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MAY, 1936

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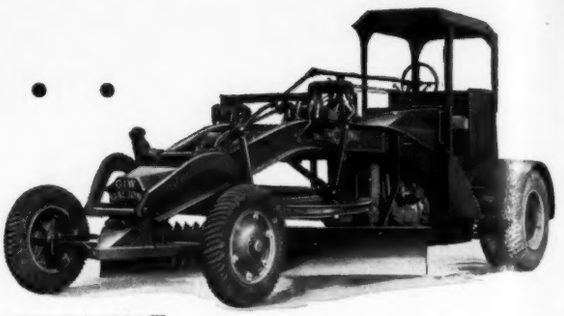

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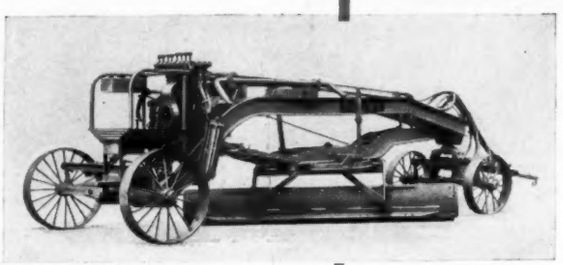

Galion Leaning Wheel Grader (right) with Hydraulic Control.

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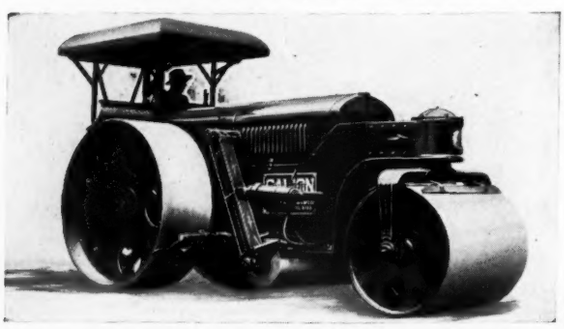
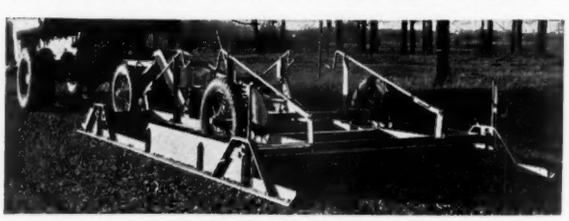
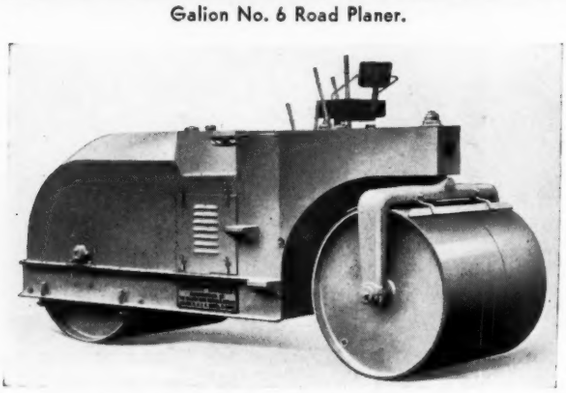


Galion "Chief" Road Roller with "Roll-A-Plane" attachment.



Galion No. 6 Road Planer.



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City, County and State Engineering and Construction

MAY, 1936

VOL. 67, NO. 5

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TIMEWASTERS

The Dead Enders:

THE matter of those dead end mains, which was unobtrusively brought up along last February is still disturbing some of the brethren. From down in Carlisle, Pa., the Home of the Order of the Boar, comes a letter—"please send the solution; about 10 of us are working night and day with no results." And so on! We thought that Mr. Tidd from little old New York had it, but a close examination shows that in one case he connected two of the dead ends—the middle red line Mr. Tidd. So we can't help our Carlisle friends yet.

Home from the Sea:

The ship mentioned by John Bevan is now 12 years old and the boiler is 9 years old. Looks easy, but a bit complicated.

That Phonograph Again:

J. K. Marquis writes in from down in South Carolina and wants to know "with what velocity was the record passing the needle when it had reached a point on the record equal to two-thirds the length of the spiral groove in which the needle travels, assuming that it required four minutes for the spiral to pass the needle?" Get out your hooks and curves for this; all contributions leading to the arrest and conviction of this problem, duly welcomed. See our December issue for the original.

Highway Special:

If the money collected in gasoline taxes from Feb. 25, 1919, when the levy was first imposed, to Jan. 1, 1936, amounted to $5,318,615,856 (which is what it did amount to) how many miles of 20 ft. wide highway could be paved with the money if it were all in pennies?

The Perfect Day:

The newspapers recently broke out in a rash statement that April 9, 1936, was a perfect day—1936 is 44 squared; 9 is 3 squared; April is the 4th month, and 4 is 2 squared; April 9 is the 100th day of the year, and 100 is 10 squared. Now that was all right, but our Canadian professor who made this discovery says there won't be another such perfect day until April 9, 2116. And right there he made his mistake, and one of our *Timewasters* writes in to say: "Some of these professors give me a distressing sensation in that part of my body which connects the head with the trunk. See enclosed clipping, and then see if January 1, 2025, doesn't fill the bill. Why wait for 2116; some of us older guys might be dead by that time. . . . It takes solvers of *Timewasters* to bring some of these birds back to earth."

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A. PRESCOTT FOLWELL, Editor — **W. A. HARDENBERGH,** Asso. Editor

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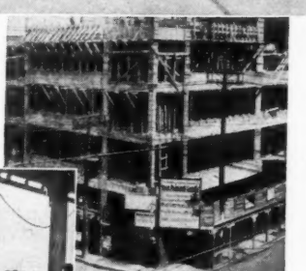

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PUBLIC WORKS

City, County and State Engineering and Construction

Vol. 67 *May, 1936* No. 5

A Stabilized Road Treated With Tarvia

Treatment of Chemically Stabilized Bases With Tar

By GEO. E. MARTIN*

STABILIZATION of gravel and similar material by the use of chemical salts has been used in a number of localities. Generally calcium chloride or sodium chloride (common salt) has been the stabilizing agent. The chemicals do their work by keeping the moisture content of the road at or near the correct amount. Combinations of gravel, clay, and chemicals have been quite satisfactory as bases to support the weight of traffic, but with increasing traffic some protective coating seems to be necessary to form a satisfactory highway surface and to water-proof the top of the road. Two questions arise: What can be used to form this surface and how can the work be done?

The construction of a traffic-resisting layer over a chemically stabilized base does not differ essentially from similar work over a macadam base or over old existing roadways. The surface chosen may vary from a surface treatment to road mix or plant mix types of appreciable thickness. In any case, a prime coat of penetrating bituminous material will be the first step.

The stabilized base to be treated should be brought into the proper condition before the prime coat is applied. In most cases the crown of the base course is greater than that required for a tight bituminous surface. The crown should be reduced to approximately one quarter inch per foot. This can usually be done easily with a blade grader. In many stabilized bases which have gone for some time without a bituminous treatment, an excess of clay binder has been brought up to the surface of the road. This layer of excess clay should be planed off with a grader blade before the bituminous treatment is started. It is scarcely necessary to say that rough and bad riding surfaces should be made smooth by dragging or blading as a part of the preliminary preparation of the stabilized base.

A tar with a low specific viscosity such as TC-1 with 8 to 13, or TC-2 with 13 to 18 as measured by the Engler instrument at 40°C has given excellent results when used as a prime coat. The selection of the proper range of tar to use will depend upon the time of year when the work is to be done and the section of the country where the road is located. In general, heavier tars are used in the South at all times and in the North during hot weather, while the light tars are better for cool weather. The road to be treated may be damp but should not be wet at the time the tar is applied. The road surface should be thoroughly swept to remove dust and other loose material. Where the road surface is solid and clean, the sweeping may be omitted.

*Consulting Engineer, General Tarvia Department, The Barrett Company.

The tar is applied by means of a pressure distributor at the rate of one-fifth gallon per square yard. This is somewhat less tar than would be used for a prime coat on an unstabilized gravel road since the surface of the stabilized road is tighter and will not absorb as much tar. In order to protect traffic this application should be lightly covered with from five to ten pounds of sand per square yard. An excess of cover should not be used since the tar should be allowed to penetrate down into the road surface, and not be drawn up into the excess sand cover. Road sweepings have been successfully used for the cover material. The sweepings have been moved from the windrow at the side of the road by means of a motor grade, and spread over the tar prime. A pneumatic tired machine moving at about twenty miles per hour has been commonly used for this purpose.

After the prime coat has been covered, it is left under traffic until a convenient time for application of the wearing surface. In practice this time has varied from five to forty days. Breaks which occur in the primed surface should be repaired at once by skin patching with tar and sand cover. Some breaks are bound to occur due to variations in the composition of the gravel, and these should be repaired while they are small.

From this point on the surfacing of the stabilized base does not differ from that of any other base. A seal coat of heavy tar with proper cover may be applied directly over the prime coat, or a leveling course and seal coat may be used, while where more strength is desired a re-tread or plant-mix top may be most satisfactory. A leveling course with a tar seal coat will probably be the best solution in most cases. For this, a tack coat of one-tenth gallon per square yard of tar TM-2 with a specific viscosity, Engler, at 50°C of 26 to 36, should be applied to the primed surface to form a solid layer or shelf upon which the leveling course can be mixed.

Aggregate for the leveling course may be stone, gravel, or slag with the following grading:

Sieve Sizes	*Total Percent Passing*
¾"	100
½"	90-100
⅜"	40-70
#4	5-25
#8	0-8

About sixty pounds of gravel or stone per square yard should be used or about fifty pounds of slag.

The aggregate should be uniformly spread over the road surface and one-half gallon of tar TM-2 with a specific viscosity, Engler, at 50°C of 26 to 36, per square yard applied to the loose aggregate. Slag will require about twenty percent more tar in the mixing course. The tar is heated for application to a temperature between 80° and 175°F.

The tar and aggregate are then thoroughly mixed together on the road by means of a blade grader or other road mixing apparatus. The tar concrete is then spread out, planed to a true surface and rolled once with a power roller. The roller wheels should be wet with water to prevent the tar coated aggregate from sticking to the wheels. A sand cover is now spread over the surface at the rate of five to ten pounds per square yard and swept into the surface voids during further rolling. Stone or slag chips may be substituted for the sand. The road may now be opened to traffic prior to the application of the seal coat, but must not be considered finished until sealed.

Tar TH-2 with a float at 32°C of 150 to 210 seconds may be used for the seal coat, although good results will be obtained with the TM-2 tar. Seal coat tar should be applied at the rate of two-tenths to three-tenths gallon per square yard. Covering aggregate should meet the following grading requirements:

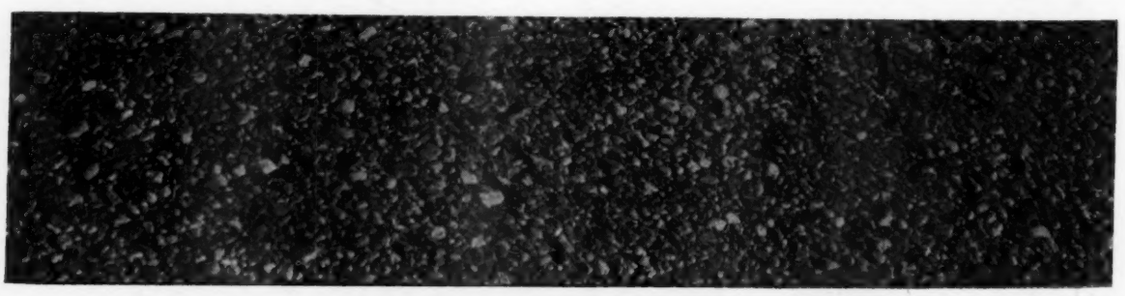
Sieve Size	*Total Percent Passing*
½"	100
⅜"	90-100
#4	10-30
#8	0-8

From ten to fifteen pounds per square yard will be needed. The cover may be swept with brooms or a broom drag during rolling, but should not be mixed with a sled drag or similar machine. This cover material is not added to take out irregularities in the road surface (there should be none at this point) but to be held on the surface by the tar binder and take the wear of the traffic.

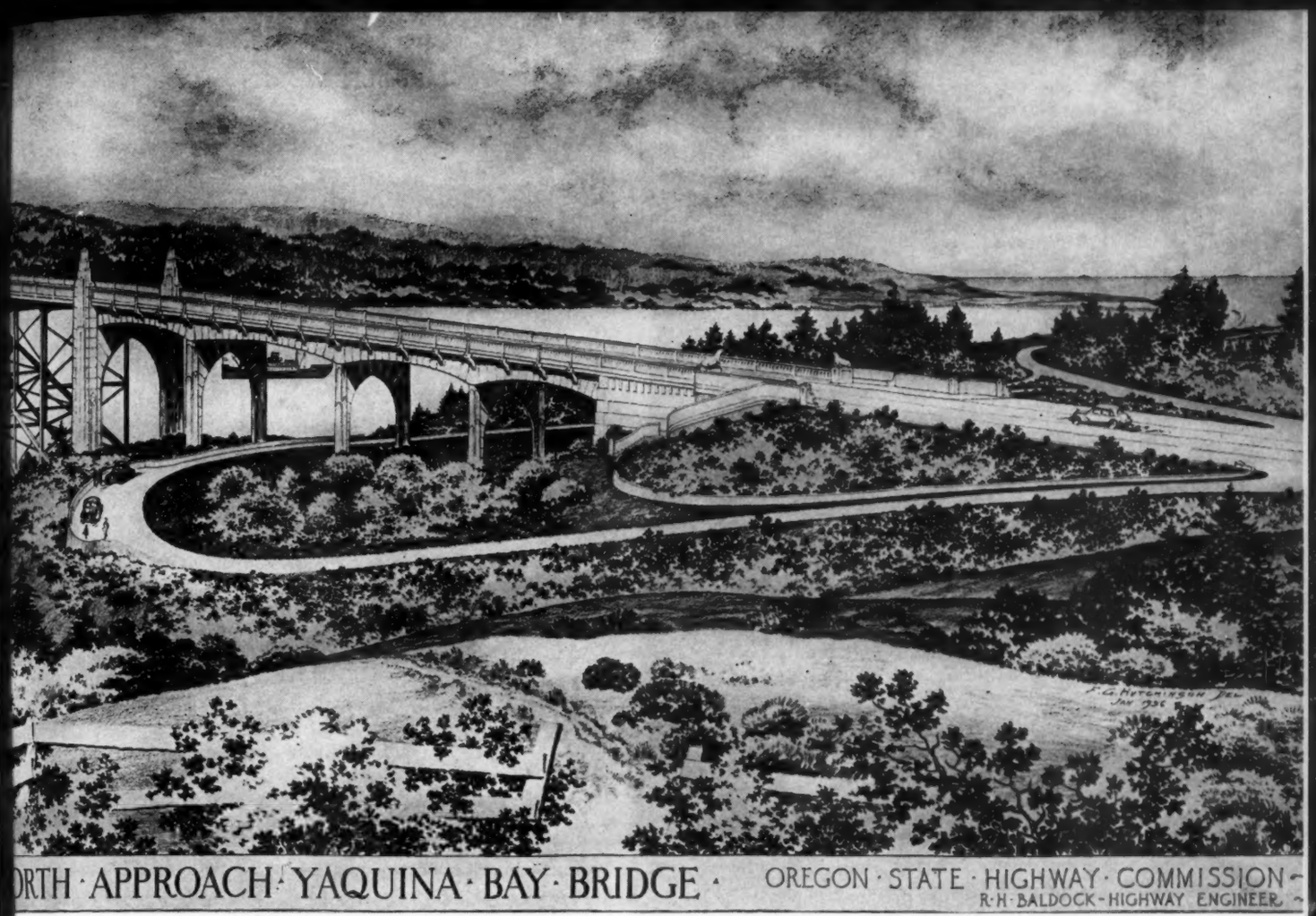
Chemically stabilized bases may be treated soon after they are constructed and in many ways this is the best practice. The chemical is uniformly distributed through the mass and can be sealed in in that condition. However, successful work can be done on stabilized bases which have been subjected to traffic and weather for some time if the proper precautions given herein are taken. Stabilized materials form an excellent base for the support of the tar surface which provides resistance to traffic and weather.

Treating Dairy Wastes in England

Dairy wastes are the worst offenders in rapidly upsetting treatment processes. Little trouble is caused during the first few days, but rapid accumulation of fat soon clogs filters. At Rothamsted (England) preliminary fermentation was beneficial; during 2 days' storage the liquid became acid and much solid matter separated as sediment and scum, and the effluent was treated without difficulty. Similar results were obtained at Birmingham, but filter clogging was also prevented by passing the liquid through two filters in series and periodically changing the order of sequence, when the slimy solid matter deposited in the top layers of the first filter became granular in character and was washed away with the effluent after the filter had been employed for secondary treatment for about a fortnight. It is generally accepted that uncontrolled discharge of dairy waste to sewers is bound to upset any type of treatment, but with proper modification it can be treated satisfactorily.



Surface of Tar Treatment on Stabilized Gravel



Roadside Beautification in Oregon

By GEORGE H. OTTEN
Landscape Engineer.

ROADSIDE beautification as undertaken by the Oregon State Highway Department is rapidly making progress with the funds annually made available under the Bureau of Public Roads' minimum allocation of 1% of all new construction money for this purpose. The program as now outlined gives every promise of being valuable, not alone in artistic achievements but also in future economic maintenance. Perhaps no state in the Union excells Oregon in variety and elegance of native shrubs and trees; therefore, except on approaches to cities and towns, where more formal development is required and appropriate, the roadside planting consists of native shrubs and trees. When one considers that such trees and shrubs as vine maple, Oregon grape, mock-orange, rhododendrons, azaleas, huckleberries, salal, snowberries, syringa, ocean spray, manzanita, myrtle, dogwoods, elder, oaks, firs, spruce and cypress are only a small part of available native materials, it is understandable why native shrubs are chosen.

Besides the infinite variety of trees and shrubs, Oregon likewise enjoys a marked diversity of climate. Roughly outlined, the Cascade Mountains, traversing the State from north to south, mark the dividing line between the regions of abundant rainfall and those of semi-arid nature. West of the Cascades little or no irrigation is required; while east of this mountain barrier irrigation is desirable. For the semi-arid or irrigated districts, roadside parks equipped with irrigation facilities are provided and are placed at strategic points where they provide delightful resting and picnic spots for the tourist.

Oregon's Roadside Improvement Policy

R. H. Baldock, State Highway Engineer, regards Oregon's highways as the show-windows of the State, and the idea conveyed in that statement is the cornerstone on which Oregon's roadside improvement program is constructed. So much of Oregon's scenery is so majestic in character that it can be seen and enjoyed from great distances. Glorious mountain peaks are almost constantly in view, not only from our mountain highways but from the valley roadways as well. It would, therefore, be improper to hedge in these vistas behind avenues of shade trees or to screen out the scenery with mass shrubbery plantations. Therefore, the Oregon State Highway Department concerns itself with conserving the top soil, which is returned to the banks and fill slopes after these have been suitably softened and rounded out to mould back into the surrounding terrain. Every effort is made to make these slopes as flat as practical, not only because they do not erode so easily

but also because the lessening of these slopes adds so much to the safety of the highway. It is a primary factor in Oregon's Safety First campaign.

Wherever practical, large through-cuts are cut through to daylight on the downhill side, and these areas thus created in turn provide suitable turnouts as safe vantage points to view the scenery. Within the span of a single growing season the top soil has healed the construction scar, and the constant ravelling and eroding, with the consequent costly hand maintenance, has been eliminated. Whatever roots, seeds or cuttings were in the top soil originally start to grow most readily when returned to the slopes, and the roots thus assist in holding the embankments in place. If planting is desired, then small shrubs are dug from among the native material in the immediate vicinity. Since this program prevails only in the areas having sufficient rainfall, it can be readily understood why in only a few short seasons the scars of construction are eliminated.

Quite often our roadside beautification has consisted of thinning out dense roadside growths so that panoramas formerly hidden are brought into the vision of the passing motorists. Sam H. Boardman, Superintendent of the Oregon State Highway Commission's Park System, has, with the assistance of the CCC groups, done a large share of this pruning work which has added so much to our highway beauty in these scenic areas. Since Mr. Boardman has approximately 100 roadside parks under his supervision, this daylighting through dense tree and shrub masses has contributed a valuable portion to the roadside program.

No set rule within narrow limits can be established for the Oregon roadside program. It is largely a scheme of conservation from the time the location engineers enter the field until the highway is turned over to the motorists. The landscape architect for the Oregon State Highway Department is consulted throughout the planning stage, and the roadside improvement is planned at the same time the engineers are planning the road construction. Because of this cooperative effort, the results obtained prove their economic value in lessened future maintenance costs. When it is considered that the use of Oregon's highways is 70% recreational, that the foreign motorist travel exceeds one-half million road miles daily on Oregon highways and that tourists are annually returning in ever increasing numbers, it is wise economy to make roadsides attractive.

Soil and Drainage Studies in Indiana

Speaking before the 22nd Annual Purdue Road School, A. R. Smith, Engineer of Tests of the Indiana State Highway Commission, discussed the work in that state on subsurface soil classification and the treatment of soils in fills, subgrades and secondary surfaces. A soils laboratory was established in the spring of 1934. Mr. Smith said:

During the first few months the efforts of this section were devoted to the study of clay-aggregate stabilization primarily for low-type surfaces. This work was soon extended, however, to include a definite program of investigation and improvement of subgrade conditions under both high- and low-type surfaces.

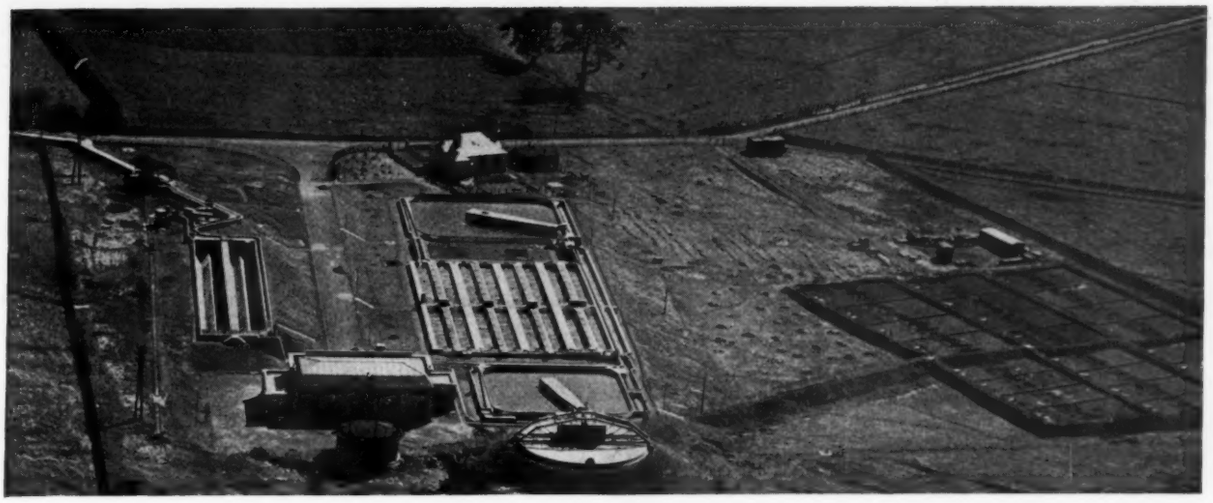
The value of moisture control in both subgrades and surfaces was indicated at an early date. Water, which is such a necessary part of most construction, becomes a definite agent of destruction if disregarded at a later date. Therefore, subsurface drainage studies were added to the program.

For the prosecution of this work it was necessary to develop both laboratory and field forces. Field survey parties working under the direction of the Bureau of Materials and Tests make sub-strata investigations with soil augers at questionable points. Any unusual conditions of soil stratification and water seepage are noted. When borings disclose that trouble would be encountered during construction, the strata are carefully mapped for the purpose of studying the soil conditions so as to devise an adequate drainage system or, if drainage is impractical, to strengthen the base.

Due to the fact that soils shrink, swell, become unstable, and even flow under changing moisture contents, we have placed most emphasis on the determination of high water tables. If a cut is made through a hill and the grade intersects water bearing strata, it is absolutely necessary that the moisture be prevented from reaching the subgrade. This condition is corrected by the interception method. Drains are placed down the side ditches or across the subgrade at points determined by the soil survey party. In many cases it is possible to protect the subgrade by placing but a single line of drains down one side ditch. Systems as simple as this, of course, are somewhat unusual but can be satisfactorily used when a porous strata intersects the center line of the road at an angle and the flow of water is across the road. In all cases it is necessary to determine the direction in which the water is flowing. If there is any doubt, the unstable area must be completely boxed with drains. For best results the water table should always be three or more feet below the subgrade. It is customary to backfill these drains with porous material.

Another function of the field survey party is to carefully sample the various soils found on the project. These are then taken to the central soils laboratory and analyzed according to the tests devised by the U. S. Bureau of Public Roads. In general, this amounts to checking the soil at various moisture contents and determining the action at these points. It is possible, after making a complete test on the soil, to determine its shrinkage, plasticity, capillarity, and elastic properties. The laboratory tests must be carefully correlated to the field conditions. A silty soil in a rolling country having a low water table will make a fairly satisfactory subgrade. The same soil in a flat country with a high water table would be very unstable in this climate.

It is my prediction that the next few years will see extensive changes in earth work construction. R. R. Proctor has established the fact that for each soil and each type of equipment there is a specified moisture content at which that soil compacts to its most dense mass. Simple tests have been devised by which the engineer can determine whether he is getting the best out of his soil and construction methods. On roads where it is necessary to compact the fill in a short time in order that a high type surface can be constructed, the use of controlled moisture contents in grading operations would be economically possible. The next step will be the combination of natural materials and cheap binders in order to provide a stable surface throughout the year for intermediate type roads. It will be an easy procedure then to construct the relatively thin wearing courses which are common today and secure a high type highway. The engineer has progressed more rapidly in designing and constructing surfaces than he has in designing and constructing subgrades and bases. However, the two are now coming to the point of equilibrium.



Airplane view of activated sludge plant at Motherwell, Scotland

Activated Sludge Developments in Great Britain

DETAILS of use of the activated sludge method of sewage treatment formed the subject of several papers presented during March by prominent English operators and students of treatment plants —E. Ardern, W. T. Lockett, H. C. Whitehead and F. R. O'Shaughnessy—before the Institute of Sewage Purification and in "The Surveyor." While no startling discoveries were announced, a number of ideas and results of experiments were described, of which the following synopsis should be interesting to American sewerage engineers:

Testing the Quality of Activated Sludge

Ardern & Lockett described some "Laboratory Tests for Ascertaining the Conditions of Activated Sludge," made with a "view of exercising some effective control over the performance of the activated sludge units at the Davyhulme sewage works." It had seemed to them probable that useful indications of sludge condition would be furnished by some, at least, of the following laboratory tests: (1) Rate of settlement, (2) Drainability or filterability, (3) Biochemical oxygen demand, (4)Oxygen absorbed from acid permanganate in 3 minutes and in 4 hours, (5) Dissolved oxygen content of the original "mixed liquor," (6) Microscopical examination. Comparisons were based on a "normal" sludge of 1.0% dry solids, of which 0.7% was organic and 0.3 mineral.

Of the various tests, No. 4 was of little service, except for indicating a thoroughly bad and putrefactive sludge, for which no test should be needed. No. 2 proved somewhat uncertain owing to the influence of the grease present; but in general, if the content of grease is low, a low rate of filtration indicates a poor condition of the activated sludge, and a high rate is definitely associated with sludges in good condition.

The other four tests were more useful. It may be said that, normally, a sludge in good condition is characterized by:

(a) Ready settlement of flocs.

(b) Rapid filterability, subject to the proviso as to grease content.

(c) A relatively lower B.O.D.

(d) The presence of certain types of larger Ciliates and the relative absence of Flagellates, Amoebae and filamentous mycelium growths.

"Of all the tests investigated, a study of the microscopical characters of activated sludge appears to afford the most valuable information as to its condition.

"The results of the present inquiry confirmed previous findings, which showed that a sludge in a bad condition contained a preponderance of Flagellates and Amoebae (and other Rhizopods); relatively few Ciliates, *e.g.*, Carchesium, Chilodon; and no Choenia.

"An unsatisfactory sludge had Flagellates and Amoebae (and other Rhizopods); some Ciliates, *e.g.*, Stentor, Paramoecia, Chilodon, Carchesium, Vorticelli; and Choenia were absent.

"A sludge in satisfactory condition possessed a few Flagellates and Amoebae (and other Rhizopods); a preponderance of Ciliates, *e.g.*, Carchesium, Vorticelli, Chilodon, Colpoda, Colpidium; some Aspidisca and Loxophyllm; occasionally Choenia, and few Suctoria.

"In a good condition (*e.g.*, when nitrification is well established) a sludge contains very few Flagellates; Amoebae are rare; there is a preponderance of Ciliates, *e.g.*, Carchesium, Vorticelli, Aspidisca, Loxophyllm, Choenia; and few Suctoria."

Improving the Efficiency of the Treatment: Adding Inert Materials

According to Whitehead and O'Shaughnessy, "The purpose of the activated sludge process may be said to be to convert impurities in water which will not settle, into a form (sludge) that will settle out in a reasonable time; and it follows as a corrollary from this that any suitable procedure which will promote settlement is advantageous. . . . A normal rate of settlement of an activated sludge in good condition built up from domestic sewage is 8 ft. per hour, and . . . a sludge which

can be relied upon to settle at more than 8 ft. per hour and at the same time retain its purification efficiency is desirable, provided its production is reasonably simple and inexpensive"; for it permits reduction in size, and therefore in cost, of the final settling tanks.

The physical basis of activated sludge is "a gelatinous matrix of protein-like character produced by bacterial agents, in water containing suitable nutrient substances and in the presence of oxygen. . . . It is advisable to have a substantial reserve of alkaline material, such as bicarbonate of lime, for when oxidation is carried beyond the point of nitrification there is a sharp fall in the reserve alkalinity of the liquid."

The slimy film from gravel in a mildly polluted stream, or the gelatinous integument which binds together particles of fine silt in a polluted estuary, looks under the microscope exactly like activated sludge, and acts like it if aerated with weak sewage. Examination of these river slimes by polarized light showed that minute particles of crystalline inorganic matter were always present; and similar examination made of activated sludges, even of the delicate flocs derived from the aeration of diluted milk, showed a small number of very minute crystalline particles.

To test out the ideas suggested by the presence of these inorganic particles, the authors tried out, as a pre-treatment to the activated sludge process, mixing with the sewage river silts, fine sand, cement, suspensions of clay and of various kinds of Fullers earth, and red marl. The cement was found to be too alkaline, but the others proved to be of definite value; the red marl most so, probably because the alkaline material in it (25% of the marl was calcium carbonate) acted as a buffering agent. But the most significant distinction between materials was that based on fineness of particles. The living agents discriminated sharply as to the dimensions of particles of foreign material which could be taken up and incorporated in the gelatinous floc. All particles larger than those of the order of 0.02 mm. were liable to be rejected, while all particles of this size or less, down to particles approaching colloidal dimensions, were taken up readily and incorporated in the floc.

C. T. Butterfield's investigation of zooglea-forming bacteria in activated sludge (see PUBLIC WORKS for May, 1935) "indicated the need for some inert foreign substances to act as a binder or framework for the floc," and he tried short cotton and asbestos fibres, the former of which gave tenacious flocs, but flocs would not adhere to the asbestos; and the authors suggest that this was because the asbestos fibres were too coarse.

In a further series of experiments, the authors mixed with the activated sludge marl, fine sand, ignited sludge ash, and manganese dioxide, after careful grinding to a state of fine subdivision. "Generally it may be said that a certain minimum quantity of each material was required to improve the settling properties of the sludge, and as the amount beyond this minimum was increased the rate of settlement was increased. Likewise, the denser the material the greater was the effect on settlement. This was followed up by experimenting with marl in a plant of 2 mgd capacity, the behavior of which was normally quite satisfactory; but when the marl was added in the form of a suspension to the sludge entering the aeration chamber, the effluent became brilliant in appearance and the settling qualities of the sludge were improved and a denser sludge obtained.

Chemical Pre-treatment

At Manchester's Withington sewage works, the sewage on Mondays and Tuesdays is much stronger and more abundant than on other days because of both private and public laundering and the plant is unable to handle it satisfactorily; and a series of laboratory experiments were conducted with a view to exploring the possibilities of some treatment of these abnormal sewages prior to activated sludge treatment. The treatment suggested was chemical dosage of the sewage, aeration of the mixture of chemical and sewage for a very brief period, followed by short-period settlement.

Tests were made with the use of ferric chloride, aluminum salts, lime, acid, calcium chloride, etc. Having regard to both cost of precipitants and clarification effected, the aluminium salts gave the best results, especially alumino-ferric. As sulphuric acid is a cheaper method of lowering the pH than excess aluminum salts, a combination of acid and alumino-ferric was tested out. The pH of 6.4 seemed the optimum and the best method of securing this (having some regard of the fact that the clarified liquid was to be treated subsequently by the activated sludge process and therefore must be definitely alkaline to methyl orange) was by first reducing the alkalinity by about half the desired amount with sulphuric acid and then adding sufficient alumino-ferric to obtain good clarification. This use of acid permitted reducing the dose of alumino-ferric by 40 to 60 ppm, and even more with very strong sewage, with as good or better results. Also gentle aeration using diffused air permitted reducing the alumino-ferric by 40 ppm or more and obtaining as good results as with the larger dose without aeration. The air was diffused through porous tile for 3 to 10 minutes only. It was found that complete sedimentation before the activated sludge treatment was not worth while, and the settling period was reduced to 30 minutes.

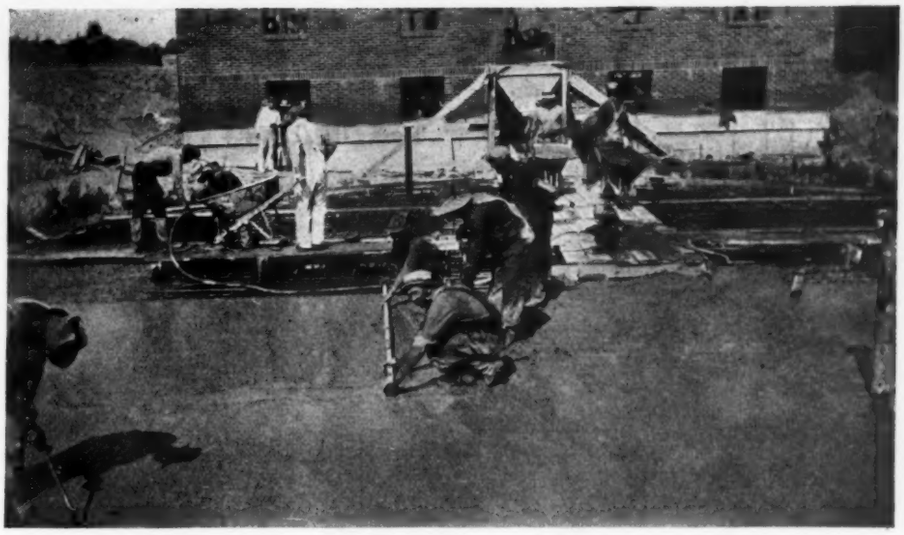
"When samples of untreated sewage and pre-treated sewage are compared, it is evident that the latter can be converted into a stable liquid in a substantially shorter period of time by means of the activated sludge process than that required for the purification of the untreated sewage to the same degree.

"The results of a number of experiments carried out on a laboratory scale showed that the purification of the clarified sewage, as obtained by pre-treatment along the lines indicated in the foregoing, could be effected by activated sludge and diffused air in approximately one-third of the time required to purify to the same degree the original settled sewage.

"In view of the temporary nature of the pre-treatment proposed—a matter of three to six hours per day on two days per week, and during dry-weather periods only—it is not thought that any serious inconvenience can be occasioned in consequence of either 'bulk' or 'low alkalinity' of the sludge resulting from the chemical treatment."

Hydrometer Method of Determining the Moisture Content of Sand

The method is based essentially on measuring the specific gravity of methylated spirit before and after the introduction of a sample of sand. 200 c.c. of methylated spirit are placed in a graduated beaker and the specific gravity measured by the hydrometer. 300 c.c. of sand are subsequently introduced into the beaker, after which sufficient spirit to enable a hydrometer determination to be made is poured off into a smaller (50 c.c.) beaker and its specific gravity measured. The difference between the two values thus obtained constitutes a measure of the moisture content of the sand sample. P. Hallstrom, Betong, 1935, (2), 66-68—*Road Abstracts.*



Concrete being placed with vibration at left as finishers complete the roof of the clear well.

By JAMES G. COONEY
Consulting Engineer
Belleville, Ill.

Vibration in Construction of Filtration Plant

THE new filtration and pumping plant recently completed in Christopher, Ill., assures that community of pure water for years to come.

There are two features of particular interest about the project: the utilization of gravity flow through the plant; and vibration in placing the concrete.

Under normal operating conditions, gravity flow is assured from the reservoir through the plant into the clear well for a large part of the year. If the aerator is by-passed, gravity flow is possible for all but extreme periods of low water.

A separate circular concrete clear well with a 2½-ft. earth cover was located at the lowest point of the site; the combined settling basin, filter units, pump room, chemical storage room and related facilities are in one unit, up the hill from the clear well, thus carrying out the gravity flow motive.

Rigid specifications were written for the concrete work and tests were required to confirm the results. The specifications set a minimum strength requirement for the concrete rather than a definite mix, the strength requirement being placed at not less than 3,000 lb. per sq. in. in compression and a modulus of rupture of not less than 600 lb. per sq. in. at 14 days. A slump of not less than 2 in. nor more than 6 in. was required. Vibration of all concrete work was specified. This made possible thinner walls and the more economical use of concrete, while the quality was improved.

In designing the clear well, the necessity of absolute water-tightness and the prevailing high ground water made a 7-in. roof and floor necessary. The design thus was resolved into a problem of locating beams and columns to utilize this slab depth most economically. Ten-inch walls were reinforced vertically and horizontally in both faces to eliminate temperature cracks and to provide for high ground water and earth pressures. Despite this heavy reinforcing and a number of large cast iron wall sleeves, a water-tight wall was easily secured with stiff concrete by use of one spud-type vibrator and two spaders.

Specifications called for an interior leakage of not to exceed 1/10 in. in 24 hours for the clear well with a 6-in. cover of water on the roof. This test was fully met. The outer surface of walls and roof was then coated, painted with a prime coat and two final coats of asphalt at the rate of 8 gal. per 100 sq. ft. on the roof and 10 gal. per 100 sq. ft on the walls.

Concrete of the clear well floor showed an average modulus of rupture of 825 lb. per sq. in. in 11 days and 980 in 14 days; of the walls, 785 lb. in 7 days and 800 lb. in 14 days; of the roof, 945 in 7 days, with a cement content of 5.46 sacks per cu. yd. A number of beams tested exceeded 1,000 lb. at 14 days.

The most economical design for settling basin walls was determined to be uniform thick vertically reinforced concrete with heavy horizontal beams at the top. Longitudinal beams at the top were tied together at the center with a "T"-beam.

With this design, an 8¾-in. vertical wall, reinforced on each side, was structurally adequate. With an 11-ft. depth and two lines of reinforcement, and with normal placing methods, good engineering practice would not consider a 12-in. wall excessive. But with vibration to assure good placement, it was decided to build a 10-in wall. The results were entirely satisfactory.

Specifications for the settling basin permitted a drop of but 1 in. in 24 hours in the water level of tanks when filled to the top. These leakage requirements were fully met and general appearance of the walls is excellent.

Test results give ample evidence of the high quality of concrete that was obtained with the vibration. This was obtained for less cost, since wall thickness was reduced without increasing cement content.

McCarthy Brothers Construction Co. of St. Louis was the contractor for the structure. The writer and the Elder Engineering Co. were associated engineers. The author personally supervised a large part of the concrete construction, with Ray Holloway serving as his assistant resident engineer. Hubert Goodell was resident engineer inspector for the PWA. This article was furnished through the courtesy of the Portland Cement Association.

Fig. 1—The eruption in the center of this road is due largely to the standing water shown at the left. Read this article to find out how to prevent this on your roads.

Road Maintenance

Is It Just Holding the Road or Making It Better?

By BERNARD E. GRAY
Chief Highway Engineer, The Asphalt Institute

THE winter from which the country is only now emerging has been the most severe in at least ten years. Very heavy snowfall, continued cold, exceptional floods and high winds, have placed a burden upon highway maintenance departments that has not been exceeded since the modern era of highway transportation began. Furthermore, in many instances, the work has been carried on with smaller appropriations than in less arduous times, and so first of all it is desired to congratulate the engineering organizations for a job which by and large has been well done.

All road surfaces have suffered, regardless of type; the rather familiar sign "Bad Bump Ahead" has not been confined to old roads or those of any particular variety, but rather has been posted at spots where for one reason or another, the subgrade has not furnished the uniform support required. However, the period has been one of especially severe test for the many thousands of miles of low-in-cost surfaces, and may be taken as affording the opportunity for a critical analysis of their ability to carry modern traffic under adverse conditions.

A careful survey indicates, that in spite of some damage these road types have held up surprisingly well. During a decade when the ground water level was consistently below normal, and when spring break-up conditions were therefore not severe, the general impression was obtained that lesser base thickness might be successful. In many instances road-mix surfaces and surface treatments were being placed on natural earth subgrades without any additional foundation. This practice was followed not only because of previous successful behavior, but also because of the pressure of public demand for more miles of dustless and mudless surfaces, particularly in those states where all or nearly all of the highways were under state control. As a result, many thousand miles of roads actually were considered as pavements that never had received any construction attention outside of the year to year betterments that were possible under very limited maintenance appropriations.

The logical procedure now is to proceed immediately to an evaluation of the damage which has occurred; (1) its extent, (2) the basic causes, (3) the remedy, (4) maintenance procedure. At the earliest possible moment a quick survey should be made either on foot or by automobile, and notes taken at each point of break-up as to: (a) character of subgrade, (b) thickness of surface, (c) open or closed texture of surface, (d) any failure of drainage. The need for immediate notes on location is because within a few weeks much of the evidence of damage will disappear as the roads dry out and the annealing effects of traffic occur. A rather broad survey already made on some two thousand miles of roads in several northern states indicate the following: (a) that with gravel or sandy loam subgrades even thin surfaces suffered but little; (b) that even on poor subgrades, any surface thickness of over six inches depth was almost 100% intact; (c) that tightly sealed surfaces were much better than those of open texture in resisting abrasion, and also in protecting the foundation; (d) and that a very large percentage of the break-ups occurred by reason of damming back of surface water on the upper side of roads, either through ice from snow drifts or where unusual rains had formed small lakes.

All these conditions are rather well illustrated in Fig. I which shows an old county road, originally built as a waterbound macadam, and then recently reconstructed with a macadam aggregate road-mix top. The subgrade is a sandy loam for the greater part, with occasional areas of red clay. The original road had a high crown which was reduced by increasing the depth of road-mix at the sides and just barely covering the center four foot width. Due to feathering at the center, the texture was rather open. The water in the field collected because of deeply frozen ground, with no provision for cross drainage. The actual depth of stone in the road center adjacent to the break was less than four inches. The road edges on either side of the break were about six inches in depth and were holding intact. On the whole project (some five miles in length), there were ten break-ups, the others being less extensive, a total of 500 square yards out of 60,000, or less than one per cent. With the installation of proper drainage,

repetition of failure would be unlikely, but with placement of increased foundation over the failed areas in addition, it will be prevented absolutely. Incidentally, this particular road has been used for a detour of trunk line traffic including the heaviest trucks, during the period frost was coming out.

It is the usual reaction in driving over such a road, negotiated previously at fifty to sixty miles an hour in comfort, to have an impression of rather complete failure, but more sober analysis will usually indicate figures about as above where any base at all has been placed. It is pertinent to enquire whether such road behavior under these severe conditions is a logical reason for designing a new pavement. A total repair bill not exceeding $200 a mile will largely prevent any future failures.

Probably the most disturbing type of failure is that of the surface treatment or thin mat top which is ravelled and broken over long stretches, with many areas which have rutted or turned over. As a pavement it would be a failure; as a maintenance treatment which has served so well as to create the impression of a substantial pavement, and as a step in stage construction, it should be considered rather as having reached a time when additional strengthening is necessary. All of the previous construction can be salvaged and, with the new treatment, will be just that much better able to resist a breakdown in the future. These apparent failures are most in evidence in those states that have included substantially the entire road mileage in their systems. Such states have been so successful in making road appropriations cover these large mileages that they have road failures in locations which in other states have not even progressed beyond the dirt stage, and which accordingly receive no comment.

Drainage

In most instances the maintenance procedure required to put the surfaces back into shape and to prevent future breakdown is well understood, but there are one or two items about which difference of opinion prevails and on which a few comments may be of help. In the first place, one still must be impressed with the chances that are taken on drainage. To be sure culverts cost money, but they do certainly pay, and rather than not have adequate cross drainage because of inability to purchase commercial products, it is better to build wooden culverts of either log or plank pending availability of additional funds. In most instances, however, funds are available to cover drainage and the corrugated iron pipe requires probably the least cost to install. Headwalls are not needed anywhere near to the extent used, and it is much better to use this money for extension of the culvert well beyond the toe of slope on the downstream side, with a very simple protection on the inlet end to prevent water going around the pipe.

For the numerous places where water backed up this spring, but where ordinarily no free surface water occurs, protection can be afforded by constructing a stone or gravel drain using large fragments as shown in Fig. II. Many such drains fail to function after a time because of incorrect construction. After digging the ditch it is desirable to construct a well bonded bed before placing the aggregate, to prevent earth from working up into the voids in the stone. This can be done by first placing a layer of stone screenings or sand, well tamped and sometimes treated with a bituminous material as a further cementing agent. The coarse stone or gravel is then filled in to the level of the foundation and covered with slightly smaller aggregate to key in the top particles. The road surface is then replaced, as in any patch. A drain so constructed will prevent the softening action of retained water, and at least some part of it will function, even during the freezing periods, so that free water will not be retained in damaging quantities.

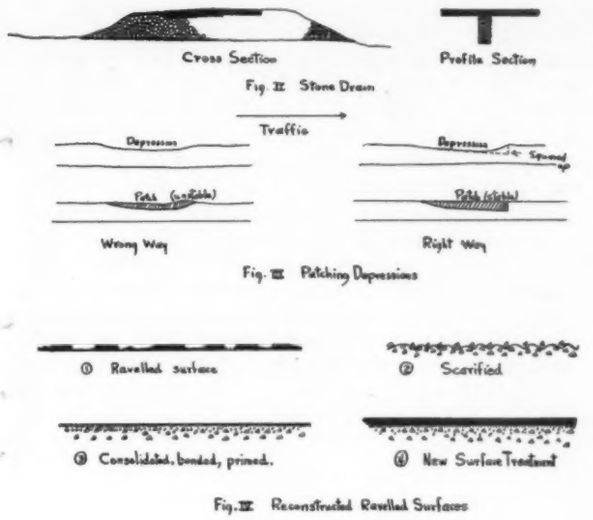


Fig. II Stone Drain

Fig. III Patching Depressions

Fig. IV Reconstructed Ravelled Surfaces

Illustrations by the author showing improper and correct procedures.

Patching

A common mistake is to patch a break-up with a thin feather edge patch, after smoothing up the bulged area. Such a repair usually requires repeated attention. This practice results from lack of sufficient written notes made at the time of worst conditions *with comment as to cause*. By the time repairs are actually made the weather is warm and mild, and the break doesn't look bad, so the patching is done along with the other surface repairs and in the same fashion. No adequate maintenance can be done without full notes, because no living person can remember all the little variations in needs of the different areas.

If a break-up results from lack of foundation, the area affected should be dug out, and new and sufficient base placed before the surface itself is renewed. A bleeder drain through the earth shoulder should also be constructed as a further insurance against wet subgrade at such points. In digging out for a new foundation, care should be taken to make rectangular openings with relatively perpendicular sides so that the new base may be more uniformly tamped and keyed in place. Even where using the old aggregate it is better first to remove it entirely, prepare the opening and then replace together with the new aggregate required.

With depressions it is not always necessary to dig out the surface, as these may not have occurred because of inadequate base but rather because of subgrade settlement. However to insure a stable patch it is desirable to make a square edge on the far side in the direction of traffic. This method is shown in Fig. III and the two sketches show typical behavior variations. Where this square edge is not obtainable, as when patching depressed Portland cement concrete slabs just beyond a joint, then especial care should be taken to insure a complete bond between the old pavement and the feather edge of the bituminous patch. When using hot or cold patch mixtures this priming is most easily done with a kerosene type of cutback asphalt because of its very high penetrating qualities.

Retreatment of Broken Surfaces

And now for comment on the thin, very low cost surfaces that have ravelled and broken quite completely.

This type of failure is inherent in the roadbed itself as a rule. It is not to be corrected entirely by drainage or a new seal coat, although attention in this direction is decidedly helpful. The need is for more depth of metal in the roadbed, and repair made accordingly. The entire road surface should be scarified and worked into the subgrade for an inch or two in depth, and then bladed and dragged to a smooth surface. If stone screenings or sand are available, the application of twenty to thirty pounds per square yard is very advantageous, and will stabilize an extra inch or two of the earth subgrade as well as cementing the old aggregate with it into a hard crust. The surface should be rolled thoroughly and then primed with M.C.-1 asphalt at the rate of one-half gallon per square yard. This material will be entirely absorbed within an hour's time and will set up in the roadbed so as to still further add to its stability and waterproofness. A seal coat should then be made, using either a cutback asphalt, an emulsified asphalt or a soft asphalt cement.

It is decidedly better, and cheaper as well, to break up completely the old mat surface and work it into the subgrade as a foundation, than to attempt to salvage it by patching and spotty retreatment. By the first method the basic weakness is corrected, the scarifying and reconsolidation are accomplished by large equipment rather than by hand patching, and the final surface presents a smooth uniform appearance. Nothing has been lost; the old aggregate is all in the roadbed, better bonded than ever, and the only new material added in addition to a retreatment has been the screenings and primer. The procedure is shown graphically in Fig. IV.

Conclusion

No attempt has been made in this article to cover maintenance procedure on the high types of bituminous pavements, such as standard hot mixes and penetration macadam on solid bases. Except for isolated breaks these types have come through the winter in excellent condition. Rather it has been felt desirable to confine the discussion almost entirely to the thin bituminous surfaces, because of the very unusual conditions of weather and the consequent increased amount of repair that is required as contrasted with preceding and more favorable years. An opportunity is now afforded to locate the points of deficiency in drainage, subgrade and surface and by proper maintenance not only to preserve the former condition, but in addition to definitely improve the roadbed so that these current expenditures will become in reality distinct betterments.

Operating a Multi-Stage Sludge Digestion Plant

FOUR and a half years' operation of the multiple sludge digestion plant of the Los Angeles County Sanitation Districts has given to those in charge interesting information on a number of points connected with digestion and gas utilization, which information was presented to the Sanitary Engineering Division of the American Society of Civil Engineers at its annual meeting by Messrs. Rawn, Banta and Pomeroy, respectively asst. chief engineer, asst. engineer and research chemist of the districts.

This plant has some unusal structural features besides being multi-stage. There are two batteries of tanks. Each battery consists of four tanks, through which the sludge passes in series, the sludge in each standing about 3 ft. below that in the preceding tank. Each tank is 56 ft. wide and 37.5 ft. long and is divided into three bays by longitudinal walls which reach down to within 12 in. of the floor; the floor slopes toward the middle axis and this toward a sump at the lower end; and each tank has a gas-tight concrete cover about 6 ft. above the sewage. Sludge is introduced into the two outer bays of the first tank, flows under the partition walls into the middle bay and thence to the sump, from this to the two outer bays of the second tank, and in like succession to the fourth sump, and then into a sludge storage well, from which it is drawn off and dried on sand beds, leveled fields, and shallow lagoons. The gas is used for heating the digestion tanks and for driving a sewage pump.

Scum forms on the first three tanks, more than 60% dry weight of which is organic matter, and this gives a higher rate of gas production than the average of the tank content. These scum mats prevent the organic matter in them from passing through the desired stage digestion.

During two years, the average reduction in organic matter effected by the 10 to 15 days in the tanks was 46.4%. Part of the time 75% of the sludge was pumped to a pit for 27 days further storage, where there was a further reduction of 14% of the organic solids added, or a total of 53.9%.

Of the average daily production of 270,000 cu. ft. of gas, 47% was produced in the first stage. Gas is used in the engine without scrubbing and after months of continuous service has shown no tendency to corrode the engine parts nor other unusual operating difficulties. However, the presence of sulphur in the gas has made itself known in other ways. Plugs of hard, grayish ferrous sulphate formed near the lower ends of the flues of the heating boiler, presumably caused by sulphuric acid dissolving the iron; this has been prevented by using forced draft which prevents condensation of water or sulphuric acid in the flues. Gas that diffuses out through small cracks in the concrete has caused slight deterioration of the concrete, and has practically destroyed some of the electrical conduits in the adjacent soil; and free sulphur has been deposited on the surface of the soil in a few small areas.

The sludge is kept at about 85° by heating coils. After 30 months' service the tanks were emptied and a half inch of limy scale was found on the coils. Removing this more than quadrupled the conductivity of the pipes, which are of extra-heavy wrought iron.

Sludge pumped to sand beds with 4.5% solids content generally gives up about half of its moisture by drainage which occurs in the first 48 hrs., and any further loss of moisture is by evaporation. When sludge originally separates from the sewage, 98.6% of the nitrogen is held in solids, the rest in the form of ammonium compounds or organic nitrogen in solution. When it leaves the tanks, 56.8% of the original nitrogen is still held in the solids; and after 23 days of additional digestion, 41.3% of the original nitrogen is still held in the solids. The nitrogen available for fertilizer value is decreased about 25% by the additional 23 days' digestion, which points to the desirability of a short digestion period when sludge is to be used as fertilizer. In which connection it is to be noted that a substantial amount of digestion occurs during drying.

The Editor's Page

The Value of Summer Camps:

Those communities which are blessed by nature with lakes and streams, mountains and forests, possess a business asset of considerable importance. In the past few years, the summer camp industry has grown in a remarkable manner. In certain sections it might almost be classed as the major industry. The annual exodus begins as soon as school closes; the return date is determined by Labor Day.

Communities which have not yet become summer camp centers may well consider the advantages of this industry—if we can call it that—and lay their plans to capture their share of it.

The scenery and the facilities for sport are important in attracting campers; even more important is the provision for health protection. A single case of typhoid fever may ruin the reputation and wholly destroy the patronage of a camp or a district. Provision for a safe and adequate water supply, for proper disposal of sewage and other wastes, and for maintaining the purity and attractiveness of waters used for swimming are all factors that demand attention.

In this issue are outlined some of the methods available for treating water supplies, disposing of sewage, etc. State or local regulations require, in many places, that certain standards of health protection should be met. Such standard requirements should be extended to cover all camp areas; and what is more important, they should be enforced by a trained and adequate personnel whose duty it should be to check on the carrying out of these standards. The protection of health is a matter of public policy and responsibility; it is also a vital necessity for every community and for every camp which wishes to remain in business.

Mosquitoes and Stream Pollution:

Some 15 years ago the quaint idea persisted among a few sanitarians that it was utterly foolish to spend money on mosquito control generally, when only *Anopheles* spread disease; consequently it was only for malaria control that communities were persuaded to make appropriations. *Culex, aedes* and others of the savage biters among the mosquito crop, a nuisance only and not a health menace, were unmolested.

Mr. Average Taxpayer might have appreciated what was being done for him if he had not been so busy slapping at the harmless, but hungry, varieties of mosquitoes that he didn't have time to read in the papers how successful the campaign was; so appropriations were not renewed, and the sanitarians with the quaint idea are now largely engaged in other work.

Let's hope that the same thing doesn't happen in stream pollution. Over a year ago this magazine urged the formulation of a national policy on stream pollution. Since then a lot of polluted water has passed under a lot of bridges, and there has been a lot of talk, but not much has been done outside of spreading resolutions on minute books.

It has been contemplated to use Federal money for a demonstration project on one of the large eastern watersheds to show what can be done, and how it should be done. We understand that a tentative selection has been made of a stream which, to the average citizen, doesn't look at all bad, except for a short distance near its mouth where very few average citizens get.

We believe that the demonstration project selected should be such that when the work has been done it will not take a chemist and a bacteriologist to determine whether any improvement has been made. The improvement ought to be such that Mr. Average Taxpayer can see with his own eyes, and appreciate, what has been done. This means that the stream selected for the work ought to be so bad before the demonstration begins that everyone knows it; then there is an opportunity for the results to make such a visible improvement that everyone can appreciate it. Otherwise, we fear that history may repeat itself, as already mentioned.

If this failure to win public approval affected only the personnel it would be bad enough and regrettable enough; but the real trouble is that any demonstration that is not successful enough to be apparent to all will do very serious damage to the movement for cleaner streams. It isn't going to be an easy job to clean up one of these rivers into which communities are dumping sewage, and big, bad industries are throwing all sorts of leftover and worthless products. Of technical knowledge there is plenty to meet all needs, of course; the obstacles will come in other ways, and from innumerable sources. Yet this is no new story in progress or in engineering. Every step forward is marked with effort. And the goal of cleaner and better streams is worth the effort.

County Highway Money:

To determine the facts about county highway expenditures for 1936, PUBLIC WORKS is making a survey, in connection with which questionnaires were recently mailed to highway officials of 2,425 counties in 39 states. (The New England states, where county organization is secondary, and the several states where counties are under state control for highway purposes, are omitted from the survey.) Already about 450 of these have been returned, and it is expected that as many more will be received within the next month or so.

Tabulations of the reports of the first 375 counties from 35 states show that the average amount available per county for 1936—taking large and small, rich and poor counties—will be somewhat over $100,000 each. If this is the true average (and we believe it is), the more than 3,000 counties in the United States will spend on highway construction and maintenance something over $300,000,000 in 1936.

This is a sizable sum, and its spending deserves the most careful planning and consideration. In connection with the spending, it is interesting to note that each county contemplates expenditure for new and better equipment for highway construction averaging about $12,500. Multiply this by the number of counties, and a sum results that should be of interest to equipment makers.

Equipment Used in Water Purification

SOFTENING

Lime-Soda Process (Continued)

In hot softening, the water is heated to approximately 200° by one of several methods. In the International plant, the water cascades over a series of superimposed trays inside a steel tank, through which steam passes in contact with the water, which falls into a mixing tank below. The lime solution is applied to the water as it enters the heating tank.

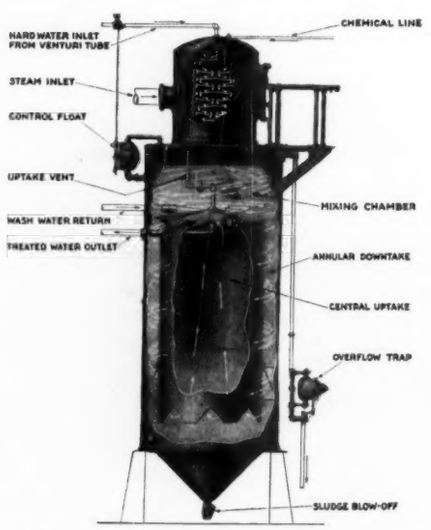
The sludge which settles in the sedimentation tank after applying the lime is very considerable, and most plants provide special equipment for removing it, either continuously or at intervals of not more than 24 hrs. This equipment has already been described under the head of "Sedimentation." This sludge is, in some cities, discharged directly into a river, but tends to settle and form obstructions in the river channel, and probably most plants will need sooner or later to provide other disposition. It can be run or pumped to low land and allowed to dry slowly; for which purpose there are available several makes of pumps specially designed for this purpose—generally a centrifugal for pumping against a low head at a uniform rate. The sludge is apt to form scale and deposits in both pump and pipe, and the former should be easily accessible for cleaning; and if gravity conveyance is possible a trough is preferable to pipe, or large-size rubber hose if the distance is not too long.

Artificial drying on sand beds, by vacuum filters, filter presses, centrifuges, etc., has been suggested and employed in some cases and may become more generally necessary as ground for dumping becomes scarce. There seems to be little prospect that the dried lime so recovered can be sold at a price which will equal the cost of drying.

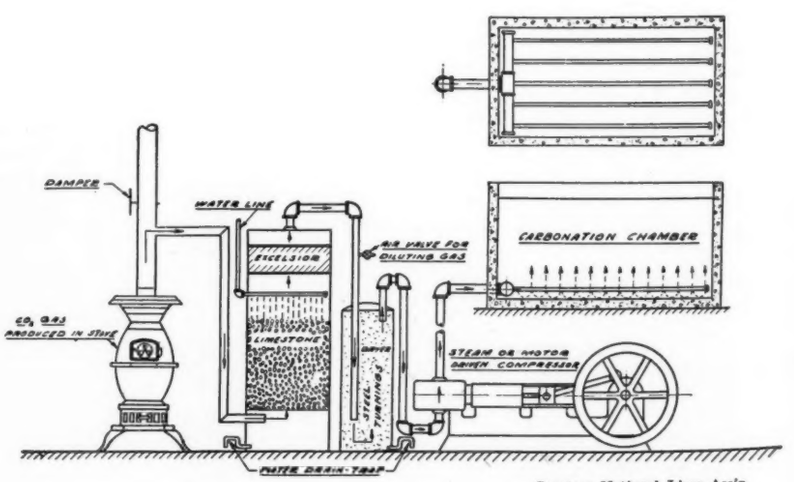
Recarbonation apparatus comprises a combustion chamber adapted to mixing the theoretical proportions of air and fuel; a washer or scrubber by which the gas is cleaned and cooled to atmospheric temperature; a drier and a trap for removing water coming over with the gas; a compressor or blower for forcing the gas into the water, and provision for diffusing it therein. There should be gauges for indicating (and recording) the amount of gas applied and the percentage of CO_2 in the gas. (See the chapter on Maintenance and Office Equipment.)

The simplest type of plant consists of two vertical tanks, one containing the gas burner and the other for cooling the gas; a compressor or blower, and a diffuser. If the quantity of water being softened exceeds about 10,000 gph. a more elaborate plant is desirable, and a scrubber and drier and moisture trap added. The fuels most suitable for this purpose are coke, producer gas made from coke, natural gas, artificial gas, fuel oil, kerosene, and anthracite coal. In choosing from these, cost of fuel is generally the least important consideration. The approximate yield of CO_2 per pound of fuel is, for coke, 3 lb.; producer gas, 3 lb.; fuel oil, 2.3 lb.; kerosene, 3.1 lb.; natural gas, 115 lb. per 1,000 cu. ft.; artificial gas, 82 lb. per 1,000 cu. ft. Coke has advantages for large plants, where a magazine-fired combustion chamber can be used; but in small ones so little is used that it is difficult to keep the fire burning properly. Gas combustion is easily controlled and clean. Next to gas, oil probably best meets all requirements for all sizes of plants—it is clean, easily handled and combustion is easily controlled. Making producer gas involves expensive equipment but is economical for large plants. Stack gases from existing boiler plants can be used, if the combustion is carefully controlled to maintain a uniform CO_2 content. Burning fuel for CO_2 produces heat, which can be utilized for heat or power (as for operating the blowers which force the gas into the water), but the formation of gas of uniform CO_2 content must be regarded the main purpose.

A coke burning plant commonly used for treating about 40,000 gph. consists of a stove, scrubber and drier, moisture trap, compressor and diffuser, as shown in the accompanying cut. The stove grate is generally proportioned to give one square foot of grate area for each 10 lb. of coke burned per hour. (In many large plants a marine boiler is used instead of a stove, the

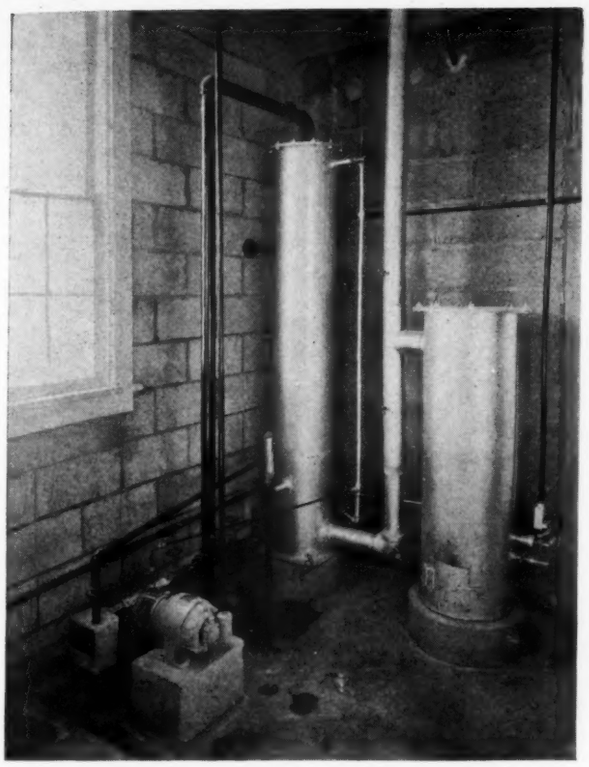


Sedimentation tank of International hot-flow softener.



Courtesy National Lime Ass'n

Carbonation plant, with coke burning stove



Carbonation equipment at Grafton, Ohio. Gas burner at right; CO_2 scrubber in corner; CO_2 compressor left foreground.

hot water being used for slaking the lime.) In the scrubber, the gas passes upward through a bed of limestone through which water is descending, then through a bed of excelsior; then through a tank of steel turnings on its way to the compressor. The walls of the scrubber, if of steel, must be protected by a brick or concrete lining; its capacity is generally made to give one cu. ft. for each 80 cu. ft. of gas per hour.

The gas, when cooled and scrubbed, is generally dried, and forced through the diffuser into the water by means of a piston compressor, centrifugal compressor or blower. As only a low pressure is generally required, piston compressors are seldom used; when used, the valves, pistons and cylinder liners should be of corrosion-resistant metal. Centrifugal or Nash "Hytor" compressors are most suitable. Generally blowers are used for low pressures, either the positive type, such as the "R.C.W." rotary positive blower; or the centrifugal, such as the Ingersoll-Rand "Motorblower" or the Allis-Chalmers "Turbo-Blower." (Blowers are noisy equipment and this should be considered in planning their location.) The blowers are driven by steam turbine, electricity, or internal combustion engine.

The diffuser may be a pipe grid, or diffusion plates or tubes ("Aloxite," Norton or "Filtros"), set in the bottom of the channel through which the softened water flows to the filter. A common plan is to set the diffusers in several rows across the channel, providing a series of "curtains" of air bubbles through which the water flows. In the case of pipe diffusers the total area of the outlet holes should be about 80% of that of the header that brings the gas to the diffuser.

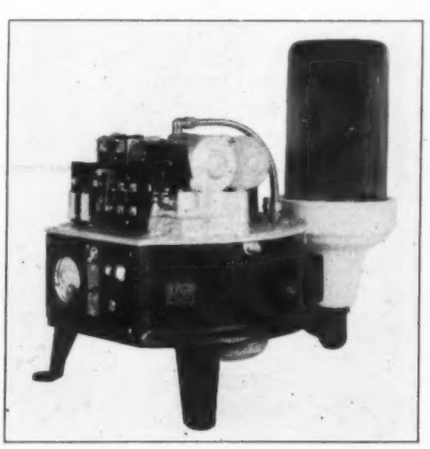
Zeolite Softeners

A zeolite softening unit resembles an ordinary rapid sand filter, either gravity or pressure, with zeolite substituted for sand; but although it would act as a filter in removing suspended matter, it should not be used for this purpose but practically all suspended matter should be removed first. Pressure filters are often used for small size plants because they can be used at higher rates; also because the water, if clear (as well water usually is) can be pumped from source of supply through softener to distribution system at one operation. Gravity filters are more accessible for observation.

Each unit should be provided with inlets for the untreated water, wash water, and salt solution; outlets for the softened water, wash water, salt solution and rinse water; meter or rate-of-flow controller; underdrainage system and graded gravel or other support for the zeolite; and sampling cocks on the outlet line of each unit. The zeolite generally has a depth of 30″ to 75″; the thicker the bed the less the amount of wash water required per 1,000,000 gal. softened.

Manufacturers of zeolite plants have greatly simplified the operation by combining control of many or all of the inlets and outlets into one multiport valve, and even making it fully automatic. The Permutit Co. provides a single multiport valve driven by a small motor connected to electrical controls; the controls actuating the motor to rotate the valve to its successive settings. When the predetermined amount of water has been softened, a meter through which it has passed closes an electric switch, causing the motor to close the raw water inlet and open the backwash; the backwash flow being kept at the desired rate by a rate-of-flow controller. The duration of the backwash is determined by an automatic time switch, which actuates the motor to close the backwash inlet and open the brine inlet. Brine from the brine tank is injected into the tank above the zeolite until a float switch in the brine tank falls to the level indicating that the desired amount of brine has entered, establishing a circuit which again operates the motor, which closes the brine inlet and opens the rinse water inlet. The desired rate of flow of the rinse water is maintained by a controller, and the time by a time switch, which, after the desired interval, again actuates the motor, which returns the multiport valve to its original position. Each of the above variables—quantity, time or rate—is adjustable independent of any of the others.

The "Solo valve" of the Elgin Softener Corporation is a multiport valve by which the wash water, brine and service inlets are opened and closed by hand by turning a single lever to different positions. The Elgin "Hardimeter" by means of the electric eye automatically tests the treated water for hardness at any desired intervals and when this exceeds a predetermined maximum it rings a bell or closes the valve to the softener tank. On regeneration, it checks the brine in the wash water so that the softener is returned to service as soon as, but not until, all trace of brine has been removed.



Elgin "Hardimeter" tests hardness at set intervals.

The water being treated may be passed either downward or upward

through the zeolite. In the upflow softener the back washing is omitted and the head lost in the softener is less. In the Elgin upward-flow softener, a bed of quartz under the zeolite acts as a filter, and a backwash manifold between the quartz and zeolite permits flushing the former as often as necessary. The American Water Softener Co. make the "Up-O-Down" softener which can be used for either upward or downward flow.

As it takes 30 to 40 minutes to regenerate a zeolite unit, either there should be a duplicate unit, or provision (such as a reservoir) for continuing the supply of softened water meantime.

Zeolite produces water of zero hardness; except that, when it is about ready for regeneration, a limited amount of water will be softened less than this by an uncertain amount. As potable water is not desirable at zero hardness, the desired degree can be obtained by mixing zero water with the proportion of unsoftened water necessary to give the desired hardness. (This is not desirable when the raw water contains much iron.) "Well water devoid of oxygen and containing carbon dioxide, if softened to zero hardness through zeolite and pumped into an iron distribution system, will dissolve iron from the mains in such quantities as to be entirely unsatisfactory for domestic use" (Chas. P. Hoover), and he suggests aeration to eliminate the CO_2 or the addition of an alkali.

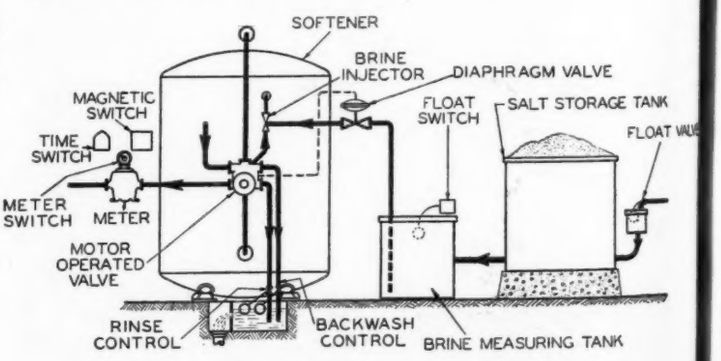
With waters high in bicarbonate hardness, lime treatment (including filtration) followed by zeolite treatment has advantages. Lime treatment can generally reduce bicarbonate hardness to 4 or 5 grains more cheaply than can zeolite; part (or all) of the water so treated is then passed through a zeolite filter which removes the remaining hardness, and this zero-hardness water is mixed with enough of the lime-treated water to give a mixture of the desired degree of hardness. Hoover says: "The cost of lime to remove bicarbonate hardness, under normal conditions, is about one-half the cost of salt" (for regenerating zeolite). "On the other hand, the cost of salt to remove non-carbonate hardness, under normal conditions, is about 20% less than the cost of soda ash."

Removing Iron and Manganese

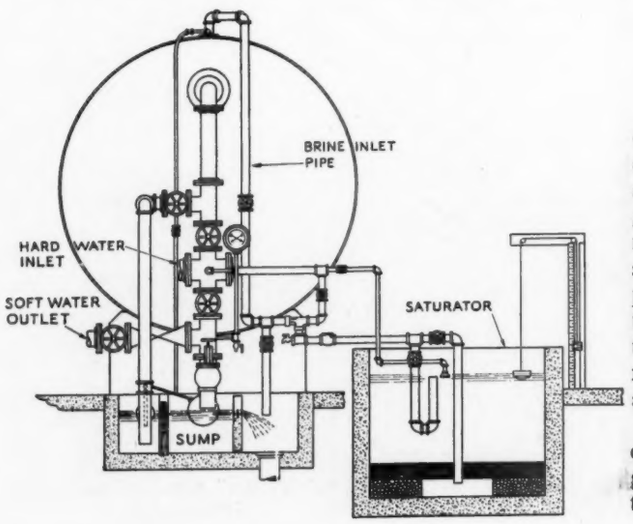
Iron and manganese are removed from water commonly by either oxidation or zeolite treatment. (The latter has only recently come into use.) The oxidation may be effected by any of the aerating devices already described. It renders most of the iron insoluble and it is then removed by sedimentation and filtration. If there is no carbon dioxide in the water, the amount of air needed is only 0.14 part for each part of iron, and such a small amount can be introduced by sniffling air into the suction pipe of a pump; but this is not sufficient if much CO_2 is present. Manganese is more difficult to remove than iron, oxidizing more slowly and requiring longer detention in the basin and sometimes special precipitants, or pre-filtration through a coke contact filter, before sand filtration.

Iron and manganese in acid waters require the addition of an alkali such as lime to raise the pH above 8 or 9. If they are present in organic combinations, addition of coagulants is necessary, for which purpose alum or lime may suffice.

Zeolites remove soluble iron or manganese simultaneously with hardness; in fact, will continue to remove them after their hardness-removing capacity begins to fail. Also special zeolites can be obtained for this purpose, such as manganese zeolite—sodium zeolite converted by manganous chloride to manganous zeolite and then oxidized by sodium or potassium permanganate, which is used for the repeated regenerations instead of salt. The zeolite filter should not be clogged with insoluble iron or manganese, whence well waters should not be exposed to air before zeolite treatment unless they are also clarified by filtration. When zero-softened water is mixed with unsoftened water to raise the hardness, the latter water can first be freed of iron and manganese by passing through manganese zeolite. A material called "Birm—a catalytic granular filter material which causes iron in water supplies to be changed into an hydroxide" and removes both dissolved and suspended iron and manganese, is offered by the C. F. Burgess Laboratories.



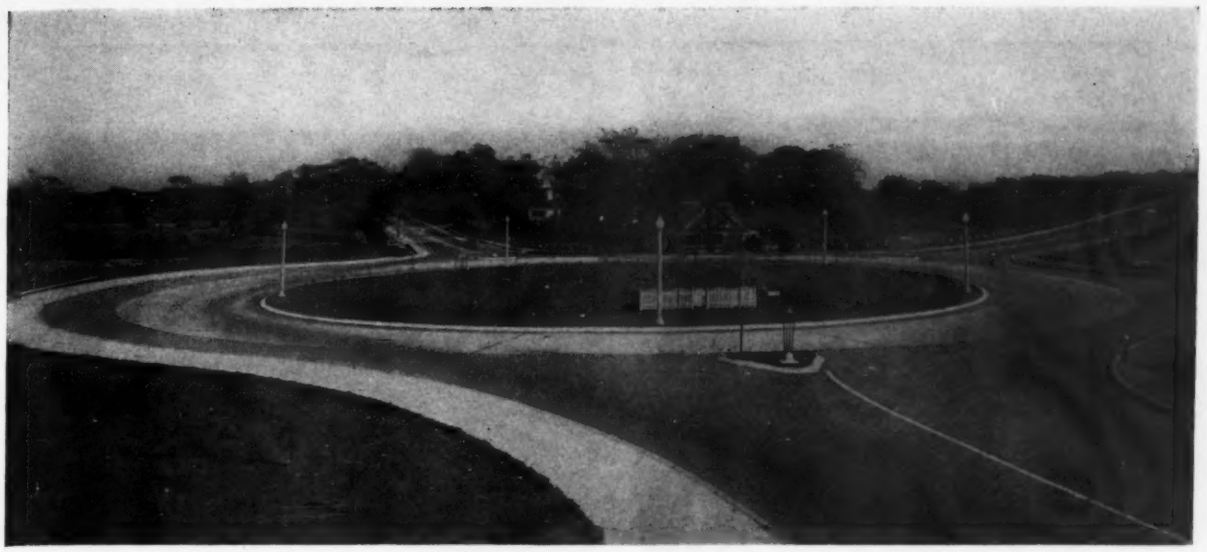
Below—Typical zeolite water softening unit in railroad service. At right—Permutit Co. automatically controlled softening plant.



Treating Swimming Pool Water

In general, the methods described above are applicable to purification of water used (usually over and over again) for swimming pools. In addition, hair strainers are desirable. As the quantities handled are generally small, several processes not often used for municipal plants are found in use for swimming pools, such as ultra-violet rays, ozone, and the katadyn silver process. It is desirable that the bactericidal effect continue during the entire time the water is in the pool, and this is claimed for the katadyn-silver process. For this reason, also, chloramine treatment seems to be especially applicable.

In outdoor pools algae growths may occur. Usually chlorine residuals of 0.2 to 0.5 ppm. will inhibit the growth of algae, but would be inadequate to remove them after they have developed.



Method of planting at traffic circles.

Roadside Beautification Notes From Massachusetts

By G. H. DELANO

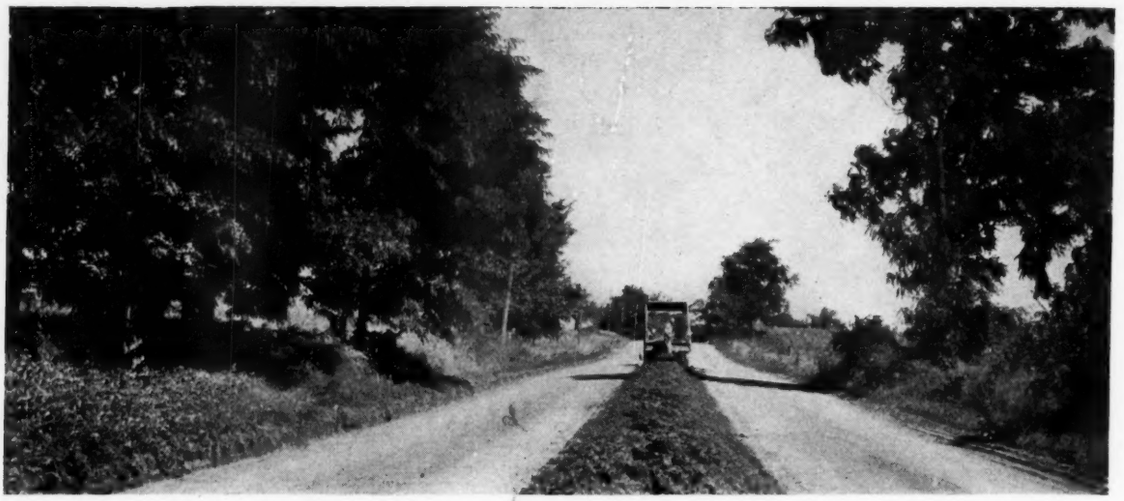
Chief Engineer, Massachusetts Department of Public Works

ROADSIDE beautification seems to be very much in the public eye at the present time and a few words on the general procedure being followed in Massachusetts is of interest.

This state, like others, after construction, has left roadside scars in the form of raw banks. These banks are being treated as far as possible by the planting of material similar to that growing in the adjoining property. If it is possible to obtain this material from the adjoining property without cost, it is transplanted from there directly to the roadside covering the scars. If this material is not available from this source then it is purchased from the local nurseries. In other sections where houses and other buildings have been constructed along the roadside, so that neither the surroundings nor the roadside conditions are natural, a more formal planting is followed.

Recently the traffic circle has come into prominence and presented a new problem in landscaping. The Department has tried to keep in mind the fact that these circles are located at intersections of routes where high speed traffic prevails. For this reason, it is necessary to provide a planting that will not obscure the conditions and at the same time indicate to the motorists that they are approaching a circle. In order to do this, in most cases we have planted a common variety of trees in the circle with a rim of white birches that will be plainly visible directly in the path of the motorists at night.

In one case where a circle is to be used to identify an airport location, the name of the airport and an arrow pointing to the same is to be made by planting *taxus nana* which can be trimmed in such a way as to make the name and arrow clear from the air. This same type of planting has been used previously by the Department on a large bank urging the public to "Keep your roadsides clean." This is shown in the illustration below.



Windrowing plant mix material in Oakland Co., Mich.

Soil Stabilization for County Roads

A PREVIOUS article (April issue of PUBLIC WORKS) dealt with some of the fundamentals involved in the construction of stabilized wearing courses and bases by the proper combination of graded stone, gravel or slag aggregates with binder-soil, moisture and calcium chloride. Special reference was made to the use of this type of surfacing for the secondary streets of cities and villages.

County officials are also rapidly recognizing the value of stabilization in the improvement of county road systems. While it is true that traffic on the more important county roads may often justify higher-cost surfaces, there are many thousands of miles of county roads on which stabilized wearing courses would serve traffic adequately for a number of years and constitute splendid bases for higher type surfacing if and when the latter became necessary.

The possibility of utilizing local soils and aggregates in the construction of low-cost all-weather road surfaces which have a full salvage value as future bases, has naturally appealed strongly to many highway engineers. There has been an increasing desire on the part of county road officials to satisfy the demands of secondary road residents by some sort of intermediate improvement, consistent with traffic and available funds, which would afford relief from mud and dust. Stabilization is the logical solution to this problem.

In the more metropolitan areas and within reasonable range of commercial aggregates plants, it is probable that plant production of stabilized mixtures might, in many cases, be the more satisfactory method of surfacing secondary county roads.

Counties operating their own screening and crushing plants in county-owned pits and quarries may well consider the addition of equipment to process their normal aggregates with binder-soil, moisture and calcium chloride. The additional units ordinarily required are a clay pulverizer or disintegrator and a mixer or pug mill, preferably of the paddle blade type. A portable stabilizer plant is now in commercial production by one manufacturer of gravel equipment and such a unit would serve as a valuable adjunct to any standard aggregate plant.

Material produced in this manner compacts rapidly, under traffic, with a dense, well-bonded wearing course. Aggregate that is lacking in the proper amount of fine binder-soil and moisture will usually remain in a loose condition, on the roadway for many months, constituting a hazard to traffic and returning little or no value in service to traffic.

The road-mix method will undoubtedly be used to a much greater extent than the plant-mix method, in stabilizing county roads. Practically every county highway department has motorized grader equipment and other tools suitable for pulverizing clay or binder-soil and mixing it on the roadway with aggregates, water and calcium chloride. This process applies to either newly-placed unstable aggregate or to the reconditioning of existing traffic-bound roads which have been scarified.

Recommended Size Gradation

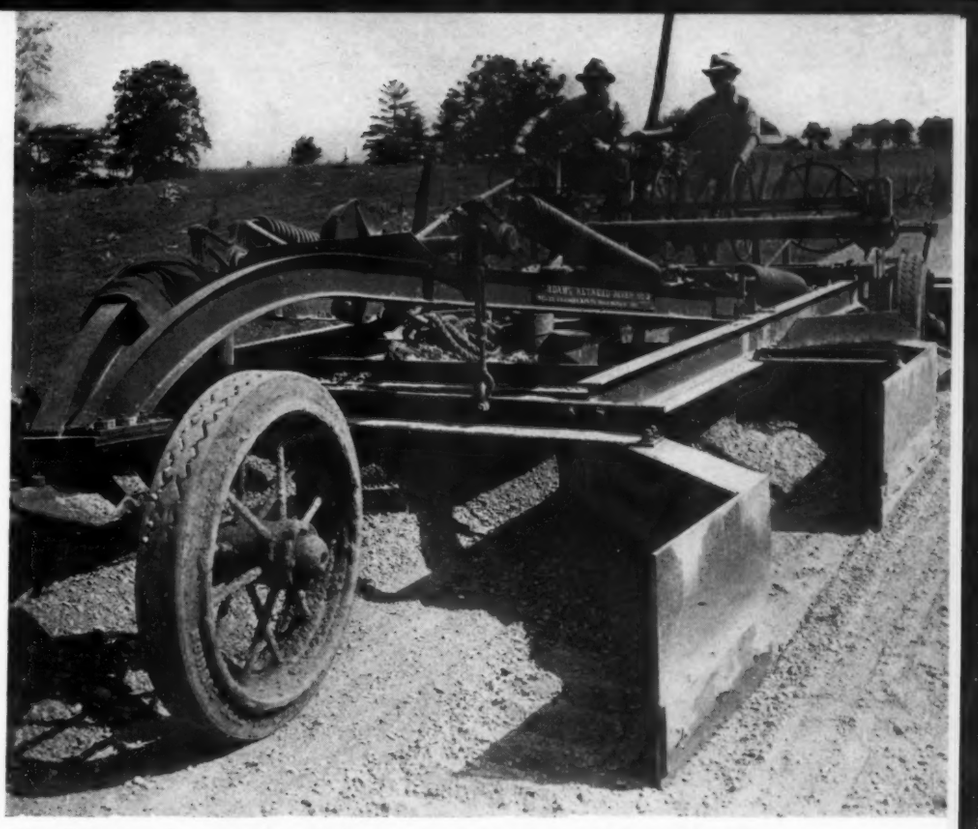
The gradation of sizes recommended for a stabilized mixture is as follows:

Passing 1-inch sieve	100 per cent
Passing ¾ inch sieve	80—100 per cent
Passing ⅜ inch sieve	50— 90 per cent
Passing No. 4 sieve	40— 75 per cent
Passing No. 10 sieve	30— 55 per cent
Passing No. 40 sieve	20— 35 per cent
Passing No. 270 sieve	8— 18 per cent

The fraction passing the No. 270 sieve shall not be more than two-thirds of the fraction passing the No. 40 sieve.

The average of the above gradation limits will produce a mixture of maximum density. In utilizing the local materials in the vicinity of any project it is often impossible to obtain an ideal gradation. The design of any mixture should, however, follow the above specification as closely as is consistent with a reasonable cost.

Provision for retaining the moisture bond in stabilized mixtures is made by including flake calcium chloride at the rate of 18 pounds per cubic yard of compacted mixture. After the material has been brought to proper formation and a fair degree of compaction on the roadway, a surface application of calcium chloride is made, at the rate of about 0.5 pound per sq. yd. Moisture films surrounding the soil particles exert a cohesive force that is one of the fundamental factors in the stability of the mixture. It is therefore of prime importance that proper moisture content be maintained. Calcium chloride, by its properties of deliquescence and resistance to evaporation, accomplishes this necessary result.



This illustration shows an Adams Maintainer at work in Brown County, Wisc., where more than 40 miles of road-mixed stabilized surfaces have been constructed during the past three years.

Laboratory control is especially desirable in the construction of the first projects in any county. After the aggregates and binder-soils from various sources have been tested and the initial projects built it is feasible to proceed with further work from the same material sources with only occasional check tests. Such laboratory control work is relatively simple. Those counties interested can obtain advice and information from the Editor of PUBLIC WORKS.

What Counties Are Doing

The following is a brief description of the stabilization work done by a few of many counties which have developed a stabilized road program:

Onondaga County, N. Y. was a pioneer in the extensive use of stabilization to improve county roads. In 1932 this county built 50 miles of stabilized gravel roads; in 1933 they constructed 285 miles, and at the present time have upwards of 500 miles of stabilized surfaces giving excellent service. These roads are maintained by occasional blading and treatments of calcium chloride.

R. B. Traver, County Engineer, at Syracuse, says, "We have found that 1 pound of calcium chloride per sq. yd. applied in the spring and from ¾ to 1 pound applied during the summer is sufficient. We find that infrequent honing, possibly two or three times a year is all that is necessary for the majority of our roads. . . . The complimentary attitude of the public is gratifying. We have had many letters from land-owners along these roads, emphasizing their approval of them and requesting that we do not change the type in the future." The road-mix method was used on all of the Ononadaga County Roads.

Brown County, Wisconsin, is another outstanding example of the successful stabilization of county gravel roads with binder-soil and calcium chloride. George J. Cormier, County Highway Commissioner at Green Bay, in an address before the Wisconsin Road School on January 28th, 1936, described his methods of doing this work. Forty miles have been improved by the road-mix method during the past 3 years. In concluding his remarks, Mr. Cormier said: "Controlling dust and thus stabilizing and making gravel and crushed stone road surfaces smoother, easier riding, and longer lasting, is one of the wisest measures road officials can take."

Oakland County, Michigan, has for the past 3 years been carrying on a program of stabilization and in that time has constructed 75 miles by the roadmix method and 5 miles by the plant-mix method. This county has followed the practice of carrying these surfaces under traffic with calcium chloride treatments for a period of 6 months to 1 year, and then covering them with thin bituminous mats. Excellent results have been obtained and further work of this kind is contemplated for 1936. Leon Belknap is County Engineer-Manager at Pontiac.

During the past two or three years this type of construction has been studied intensively by a number of state highway departments, and *many* developments have been uncovered which make for simple construction processes. As a result, the field of use is rapidly being extended. A number of counties, covered in a recent survey by this magazine, have indicated their intentions to construct stabilized surfaces during the coming construction season; and there is every reason why smaller governmental units, such as townships, should be interested, because stabilization offers to them a most promising—and an already tried and successful—method of low cost road construction.

Proper drainage is a prime requisite for roads of this type. In this and coming issues of PUBLIC WORKS, this important subject will be covered from the viewpoint of the county engineer. Attention is also called to an article in this issue on bituminous surface treatments for stabilized roads. Available publications and data on all three subjects will be sent to readers on request to the editor. Please make requests as specific as possible.

Chlorinating Sewage on Ships

LT. COL. A. W. SWEET,
Sn.-Res., U. S. A.

FOR many years there has been no restriction upon disposal of raw sewage into navigable and tidal waters from ships of all types. This condition has been permitted both while the ships are in motion and when at anchor or moored to piers. This system is often considered a negligible pollution factor but may easily become a public nuisance when it is permitted in a harbor of limited size or when the ships house large numbers of passengers and visitors during the intervals between scheduled sailings. Recently unfavorable criticism of the bathing waters adjacent to a New Jersey municipality appeared in a metropolitan newspaper having a wide circulation. The municipal Board of Health served notice upon two steamship lines to cease the discharge of raw sewage into the bay. Effluent from its own sewage disposal plant discharged into the bay waters but the municipal wastes were treated and chlorinated.

The pollution was promptly stopped by the ship companies although one line had been running steamers and holding them at their piers for varying periods daily in summer and no complaint had been made for over forty years. The adjoining state did not require the ship companies to treat these wastes before discharge into local harbor waters or slips while moored to piers. Obviously if a city does not treat its own sewage wastes before disposal to a stream or harbor it cannot with justification require private industry to remove polluting material from its waste disposal system before discharge.

The officials of both companies submitted plans of treatment after conferences with sanitary engineers. The system recommended and installed in each ship was put in operation at the beginning of the past summer season and has been checked at intervals during the past year.

The raw sewage was formerly diluted with wash waters and discharged without storage by gravity flow. This plan was changed to permit separation and collection of sewage wastes from all lavatory and water flush toilets, fixtures and kitchen wastes. A treatment tank was constructed in the hold with two or more baffles to prevent the discharge of any solid materials and to permit more storage time for effective disintegration and reduction. The overflow was connected to the old gravity discharge line. Hypochlorite of lime solution was injected into the intake line of the tank to better mix with and sterilize the sewage by a chloroclock apparatus.

Since interstate waters are traversed on the course of these steamers it was necessary to designate a point for the starting of the chlorine dispensing apparatus. It was also stipulated and agreed to by the ship companies that the treatment tanks might be discharged at any point beyond the New Jersey State line. This plan afforded an opportunity for the tanks to be cleared of solid materials and discharged where the dilution and ocean currents would remove the danger. The chief engineer was placed in charge of the disposal system.

A storage tank was constructed in the holds of each of the three steamships affected. The basis of design, in all cases, was as follows: All toilets on these ships discharge 1½ gallons of water when flushed. Assuming that the toilets would be flushed every 3 minutes, there would be 30 gallons of sewage per hour per toilet. One of the steamers had 14 toilets; another 15. For the former a flow of sewage of 420 gallons per hour was assumed. A tank of 460 gallons capacity was installed, giving a detention period of slightly over 1 hour. In the other ship, the dimensions of the hold limited the tank to a capacity of 360 gallons.

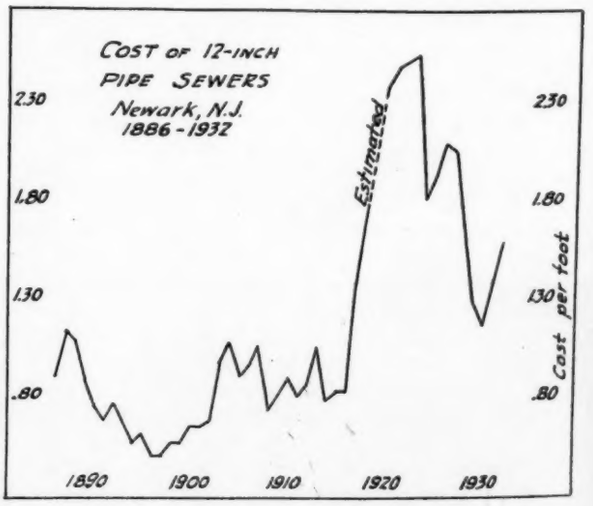
With an assumed 24-hour operation, the total flow would be 10,800 gallons per day. A dosage of chlorine of 20 parts per million was applied at the inlet of the tank, using a Wallace & Tiernan Co. "Chloroclock." The required daily dosage would be 1.8 pounds of chlorine, and the equipment used has a capacity of 2.2 pounds per day, using a 10% solution.

Chlorine was applied only on the southbound trip, beginning at a point about 20 minutes sailing time from the New Jersey harbor, and discontinued on the northbound trip at the same place.

Installation of such simple sewage treatment devices should provide considerable protection to bathing beaches and shellfish bed and should be of interest to municipalities which are faced with the problem of unpleasant or dangerous harbor contamination.

Cost of Pipe Sewers During Forty-Seven Years

In 1924, Public Works published a chart showing the cost of 12-inch pipe sewers, laid by contract in Newark, N. J. The data for this were furnished by E. S. Rankin, Division Engineer of the Division of Sewers, and covered the period from 1886 to 1923. At our request, Mr. Rankin has brought the chart up to date by sending figures for the years 1923 to 1932, inclusive, but he says: "For a number of years our use of small pipes has been very limited, . . . and since 1932 we have not built any small pipe sewers by contract."



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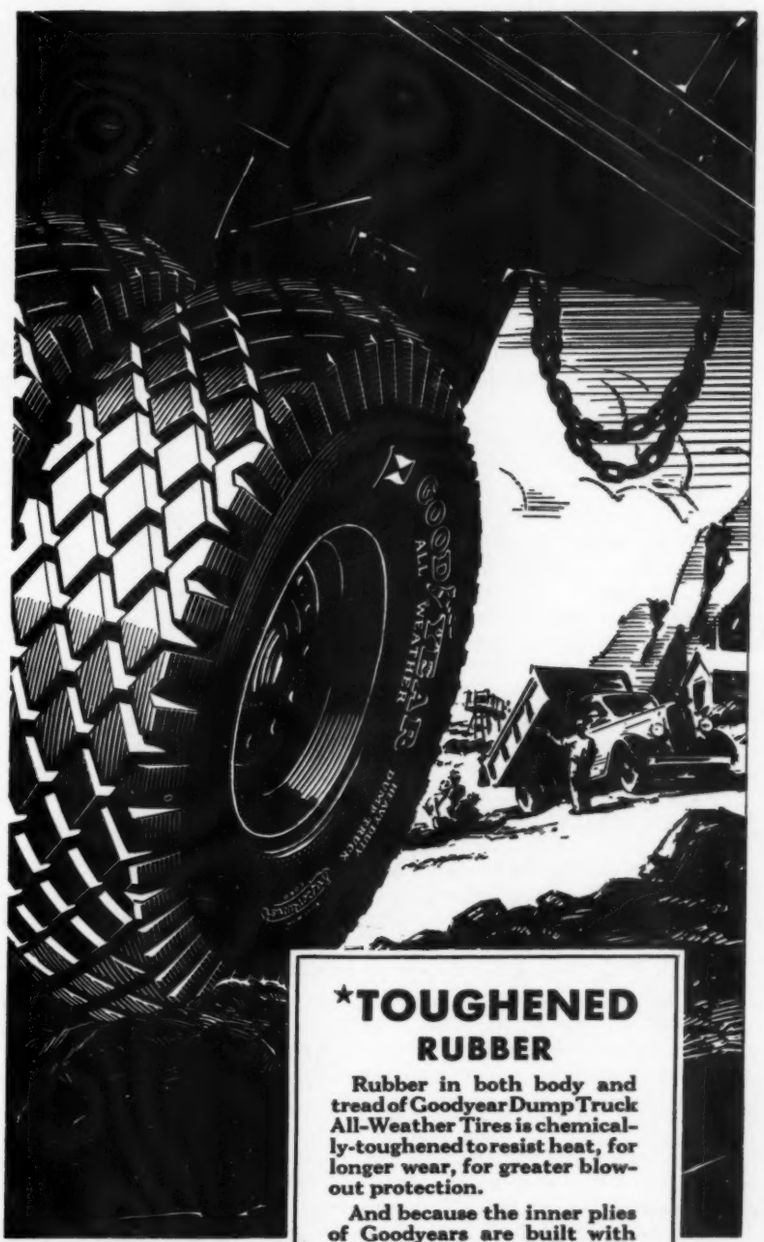

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A Digest of the Sewerage Literature of the Month giving the main features of all the important articles published

The Digestion Tank

Sewage Works Journal

Zig-zag screen at Ravinia, Ill.

A **bar screen** of a new type has been tried by A. L Gail at the Ravinia, Ill., plant with very satisfactory results. His aim was to protect pumps from large objects such as sticks and wire, but permit rags and paper to pass to the tanks. The trial screen was constructed of 4 sheets of 12-gauge galvanized iron bent to zig-zag form standing vertically in the sewage channel, closer together at the down-stream end than at the up-stream so that a stick will wedge between the sheets. Rags and paper, however, pass through. This screen replaced, in September 1935, a screen with 1½" openings, and, with the same flow, shows a loss of head of 1.6 to 2.0 inches as compared to 7.25 to 11.0 inches with the old bar screen, and is cleaned once in two weeks or longer while the old screen had to be cleaned daily.

As this screen constricts the channel, it might be desirable to expand the channel where the screen is located. Also, a permanent screen of this kind should be made of heavy metal, stiffened and anchored.[C11]

Chemical treatment at the Shades Valley (Birmingham) plant was employed from June 15 to November 11, 1935, the plant being operated as a sedimentation plant for primary treatment during the remainder of the calendar year. Results exceeded the expectations of the designing engineers, continued satisfactory results being obtained at very reasonable cost. Digestion of mixed raw and chemically treated sludge has been accomplished by means of two-stage digestion, with the production of an excellent overflow liquor comparable in strength to raw sewage. Coagulation by means of a ferric iron salt, without previous pH value adjustment, is considerably cheaper than with the addition of acids or alkalis. Although the preliminary removal of settleable solids did not result directly in a reduction of chemicals required, pre-settling has definite advantage, especially when combined with return of chemical sludge. Returned chemical sludge materially reduces suspended solids and BOD in the primary settling tank, but continued recirculation of sludge may give trouble because of reduction of ferric iron. Laboratory experiments indicate that mixed or chemical sludge may readily be concentrated by storage; a higher final density being obtained in the case of the mixed sludge. The coarser non-settleable solids coagulate more easily, making possible a varying degree of treatment, depending on the amount of chemicals added.[C5]

Incineration of sludges involves use of fuel to supplement the fuel value of the sludge itself, and the greater the amount of inert material, in the form of chemicals, added to any sludge in order to render it filterable, the less the fuel value of the sludge becomes and the greater the amount of extraneous fuel that has to be added for incineration. During incineration of sludge to which lime has been added, considerable heat is consumed in dehydrating the chemical compounds and producing oxides and possibly silicates. Addition of iron tends to lower the fusing point of all materials forming silicates and clinker when burning sludge.

By elutriating the sludge before incineration the use of lime can be entirely eliminated and the amount of ferric salts added for coagulation purposes can be materially diminished; thereby definitely diminishing the constant daily costs of dewatering and incinerating the sludge.

It is believed that the most economical means of disposing of raw sludge is by digestion, elutriation and dewatering on vacuum filters, either with or without final drying and incineration. With modern separate digestion tanks followed by elutriation and vacuum filtration it is not necessary to continue sludge digestion to the point necessary for dewatering on sand beds.[C6]

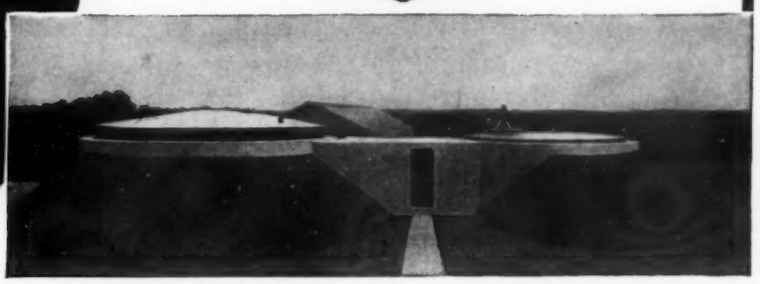
Rate of **oxidation of sludges** is generally measured by determination of the oxygen absorbed, and Heukelekian, believes that "there has been a need for a rapid and accurate method of determining the rate of oxidation of sludges," one less complicated and using less expensive apparatus. With a view of using the production of CO_2 for this purpose, he endeavored to evaluate the rate of oxidation of sewage and sludge by use of an index of CO_2 production. But he concludes that "It will not be possible at present to use the CO_2 production as a basis for the computation of oxygen demand." Comparing this with the BOD method "it was found that CO_2 production from sewage and activated sludge was higher than the oxygen consumption by the dilution method, resulting in CO_2 to BOD ratios greater than unity. With fresh solids, on the other hand, ratios less than unity were obtained."[C3]

Sludge bulking was studied by the Stream Pollution Investigation Station of the U. S. Public Health Service, with the following conclusions: "There are at least two distinct conditions of sludge floc, either of which when present will cause the sludge to settle with difficulty, if at all. One is a thin, diffuse or spongy, ragged floc, that tends to float because of its relatively large surface area; the other is a floc possibly of moderate or good quality, but heavily infested with thin fungus threads which extend out in all directions from the main body and thereby increase greatly the buoyancy of the floc and doubtless separate materially the individual particles. All gradations and combinations of these two conditions may occur in specific instances." The remedies for the two causes will generally differ, and frequent periodic examination of the sludge floc in a cell under a microscope magnifying about 20 to 30 diam-

Economics OF SLUDGE DISPOSAL BY DIGESTION . . .

SEPARATE SLUDGE DIGESTION is the cheapest and best justified element in sludge disposal practice—regardless of the treatment process preceding it or the capacity of the plant. Our convictions on this much-discussed matter of sludge disposal economics are set forth below.

DORRCO



A Dorr Multdigestion System at Cedarhurst, New York

CHEAPEST SLUDGE DISPOSAL PLANT TO BUILD—

Digestion of Sludge, followed by Vacuum Filtration

Plant Sizes:	*Plant Types:*
2 to 100 M.G.D.	*All except one*

Exception—*In activated sludge treatment the cheapest combination is vacuum filtration of the combined digested primary sludge with the undigested activated sludge.*

CHEAPEST SLUDGE DISPOSAL PLANT TO OPERATE—

Digestion of Sludge, followed by drying on Beds

Plant Sizes:	*Plant Types:*
2 to 10 M.G.D.	*All*

Digestion of Sludge, followed by Vacuum Filtration or Vacuum Filtration and Incineration

Plant Sizes:	*Plant Types:*
10 to 100 M.G.D.	*All except one*

Exception—*In activated sludge treatment, as noted before.*

MOST COSTLY BOTH TO BUILD AND OPERATE—

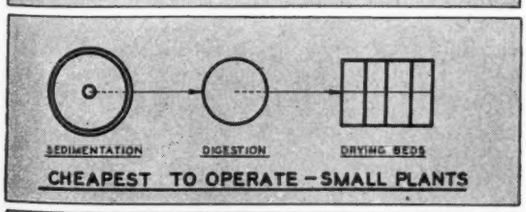
Disposal Methods, handling Raw, Un-digested Sludges

Plant Sizes:	*Plant Types:*
2 to 100 M.G.D.	*All*

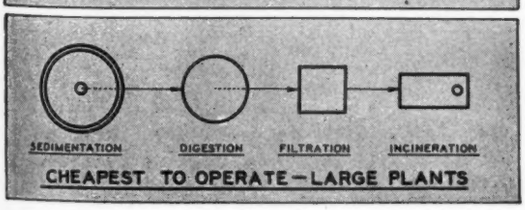
FUTURE TRENDS—

Digestion of Sludge in all cases, followed by Vacuum Filtration in smaller plants and by Vacuum Filtration and Incineration in larger ones.

CHEAPEST TO BUILD



CHEAPEST TO OPERATE—SMALL PLANTS



CHEAPEST TO OPERATE—LARGE PLANTS

The conclusions cited above were drawn from a detailed economic study * comparing the installed and operating costs of the various methods of sludge disposal being advanced today.

Comparisons were made for plants employing primary treatment alone or in combination with trickling filters, chemical precipitation and the activated sludge process. Costs were computed for capacities of 2, 5, 10, 25, 50 and 100 M.G.D.

Disposal methods evaluated consisted of digestion, open and covered drying beds, vacuum filtration and incineration—alone or in combination.

SEE OUR CONDENSED CATALOG IN MUNICIPAL INDEX

* We will gladly send you, on request, a copy of this report, including 6 tables and 16 charts of cost comparisons.

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eters is essential to determine the condition of the sludge floc in its natural environment.

Chlorination of the return sludge at rates between 0.7 and 7.0 ppm based on return sludge, or .01 to 0.1% based on weight of dry solids (depending on character of sludge floc) is a useful method for combating bulking due primarily to fungus growth, but is not successful against that type of bulking due to light, diffuse floc. Chlorination is attended by serious danger of overchlorinating and destroying the desirable plankton growths and requires constant, careful supervision.[C4]

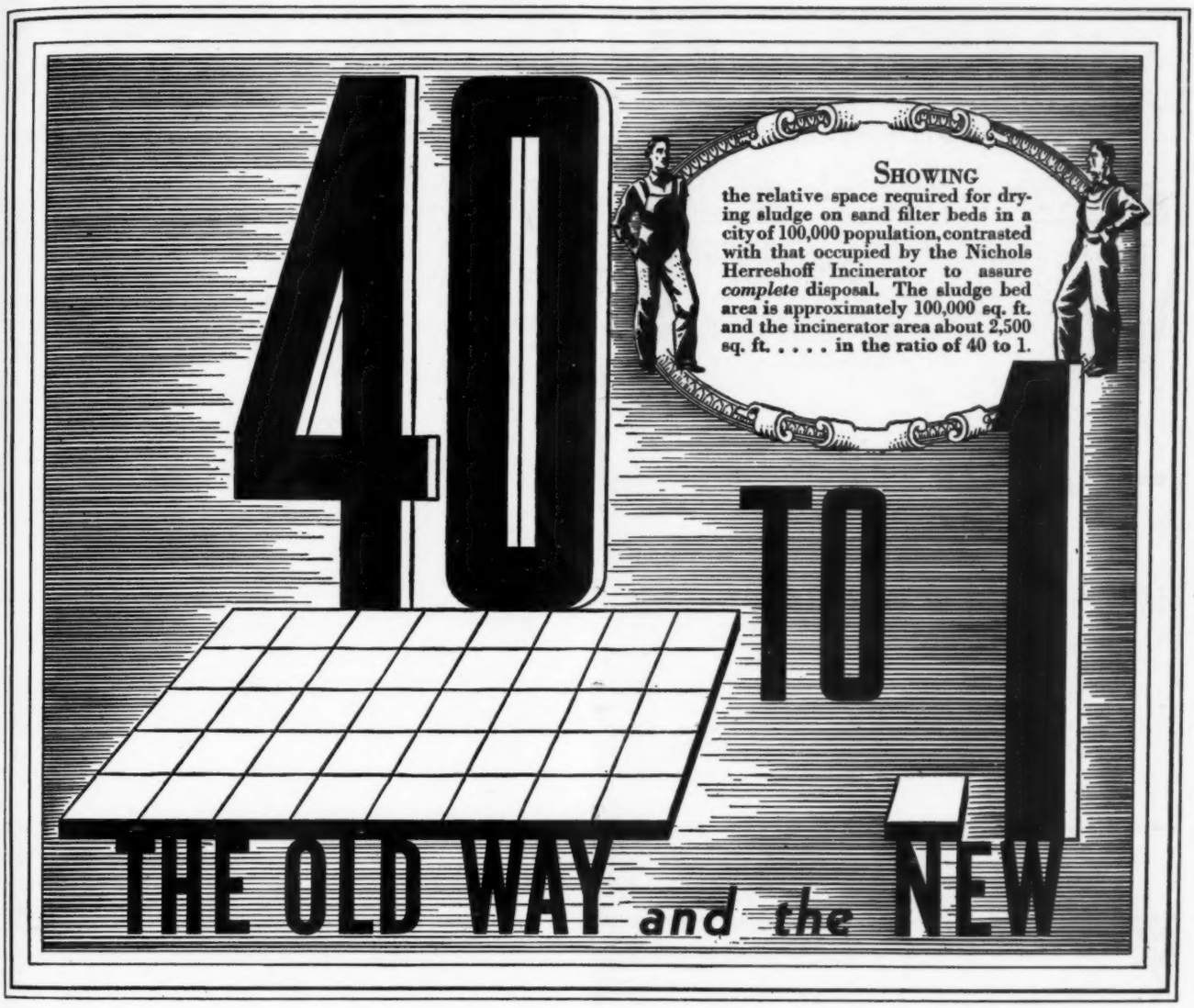
In **sewage coagulation** there are in general two zones of pH values where optimum removal of suspended solids takes place. These zones are shifted or modified with variations in septicity, quantity and type of trade waste, and quantity of iron coagulant used—the first much more important than the last. Maximum removal of suspended solids is greater in the acid than in the alkaline range. Coagulation of stale sewage containing large quantities of finely divided suspended solids is probably accomplished most successfully in the alkaline range, but other factors may modify this conclusion.

All sewages behave fundamentally the same when iron coagulants are used, but the results obtained will vary with the type of sewage to be treated.

In chemical treatment the quality of the effluent and the efficiency of the treatment can be judged quite accurately and rapidly by turbidity measurements. Suspended solids removal can be estimated from the turbidity figures so that the turbidity measurement can be used as a rapid tool for operation and control. In general there is also a relation between the removal of turbidity and BOD reduction. Turbidity measurements are of little practical importance where more specific results are required, but permit adjustment of chemical dosage immediately to suit conditions. The simple turbidity measurements of the effluent and pH determinations of the sewage and effluent give the operator two handy tools whereby the process can be controlled and the dosages of chemicals regulated with a good measure of dependability.[C2]

Industrial Wastes can generally be treated at less cost with city sewage, when this is practicable, than to an equal degree separately. But the problem of treatment at isolated plants by the manufacturers is usually not so difficult as they would have us believe. "In such situations the difficulty has frequently led to intensive study of methods of re-use, re-circulation and recovery of solids within the plant. A few references to outstanding achievements in this respect are: the 'bottling up' of corn products wastes at Argo, Pekin, Cedar Rapids and Decatur; the recent installation of filters and evaporators at the Hiram Walker distillery in Peoria; the recovery of 'white water' solids in paper mills; the Howard process for recovery of sulphite and combustible solids from sulphite liquor; the extraction process for recovery of phenol from by-products coke plant wastes; the recovery of acid sludge in oil refineries; and the recovery of acid and iron from pickling liquors.

"In other cases industrial wastes have been treated by sewage treatment processes in plants built by the industries, such as: the Winslow Brothers tannery waste plant and the Bird & Company textile waste plant in Massachusetts; the various cannery waste plants in Wisconsin; the Hormel packing house waste plant in Austin, Minn.; the Decker packing house waste plant in Mason City, Ia.; and the plant for treatment of mixed dairy and laboratory wastes at Beltsville Center, Md."[C9]


40 TO 1
THE OLD WAY and the NEW
SHOWING
the relative space required for drying sludge on sand filter beds in a city of 100,000 population, contrasted with that occupied by the Nichols Herreshoff Incinerator to assure *complete* disposal. The sludge bed area is approximately 100,000 sq. ft. and the incinerator area about 2,500 sq. ft. . . . . in the ratio of 40 to 1.

NO better evidence shows the compactness of a Nichols Herreshoff Sewage Sludge Incinerator installation than the comparative illustrations herewith. They graphically visualize the economy of space made possible by this improved, scientific way to dispose of sewage sludge solids by *burning*. The resulting residue is a dry, odorless, virtually inorganic ash. Minimum labor and maintenance costs also assure maximum economy of operation.

Engineers and public officials interested in solving municipal waste disposal problems by this economical, sanitary method are invited to send for more complete details.

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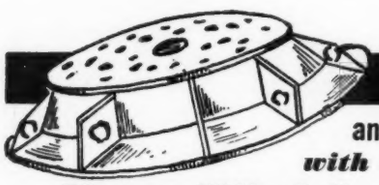
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Garbage disposal by grinding and mixing with sewage "should be adopted only after the most careful study." In some plants where tried, it increased the screenings by 50% or more, the volatile solids in the grit by 100%, the scum by 300%, and settling tank effluent BOD 15 to 20%. Digestion tanks or Imhoff tanks seem to function as readily with as without garbage if properly seeded and the amount of garbage is not too great.

As to cost, household grinders cost $160 each and even if reduced to $100 would not probably be generally adopted, so cost of collection would not be eliminated. Two estimates of the cost of operating a grinding station are 37.2 and 42.6 cts. per ton, including overhead. Digestion and drying cost an average of about $2.81 a net ton in Illinois. Handling additional screenings, grit, scum and grease might bring the total to $3.50. Moreover, since the sewage would be much stronger, the secondary treatment units might need to be enlarged. The total cost of incinerating garbage should not average more than $2.50 a ton, or 60% to 70% as much as grinding. Garbage grinders are noisy—can be heard 400 or 500 ft. away—and odorous, and are almost as undesirable neighbors as incinerators.[L4-3]

Bibliography of Recent Sewerage Literature

c, Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

C *Sewage Works Journal*
March

1. Research in Sewage Chemistry, Sewage Treatment and Stream Pollution. By H. A. Faber, W. S. Mahlie, W. Rudolfs and E. B. Phelps, pp. 161-194.
2. *t.* Chemical Sewage Coagulation. By W. Rudolfs and H. W. Gehm, pp. 195-209.
3. *t.* Carbon Dioxide Production in Mixtures of Sewage and Activated Sludge. By H. Heukelekian, pp. 210-222.
4. The Use of Chlorine for the Correction of Sludge Bulking in the Activated Sludge Process. By R. S. Smith and W. C. Purdy, pp. 223-230.
5. Experiences with Chemical Treatment of Sewage at Birmingham, Ala. By H. H. Hendon, pp. 231-247.
6. The Economics of Various Methods of Sludge Disposal. By A. J. Fischer, pp. 248-271.
7. Policies and Progress in Sewage Treatment in New York State. By E. Devendorf, pp. 272-281.
8. Experimental Study of Atmospheric Reaeration Under Stream Flow Conditions. By H. W. Streeter, C. T. Wright and R. W. Kehr, pp. 282-316.
9. The Industrial Waste Problem. By F. W. Mohlman, pp. 317-318.
10. Suggestions to Plant Operators. By C. Klassen, pp. 327-328.
11. A New Type of Bar Screen. By A. L. Gail, pp. 329-331.
12. Sludge Dewatering on Drying Beds. By C. H. Young, pp. 331-334.
13. Operation of the Norristown Sewage Treatment Works. By F. B. Altemus, pp. 334-337.

E *Engineering News-Record*
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1. Sanitary Fill Refuse Disposal at San Francisco, pp. 314-317.
2. Developments in the Operation of Sewage Treatment Plants, pp. 321-322.

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3. Twin 36-Inch Wood-Stave Pipes Moved Bodily Across Channel, pp. 447-448.
4. Chemical Precipitation to Be Used at New Brunswick Sewage Plant, pp. 448-449.
5. Digestion Tank Piping Simplifies Sludge and Supernatant Draw-Off, p. 449.

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6. Simplifying Determination of Diluting Capacity of Stream. By J. R. McComas, p. 501.

April 9

7. Seven Years' Study Back of Twin Cities Sewage Disposal Plan. By F. Bass, pp. 527-530.

H *Municipal Sanitation*
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3. Motorcycle Oiling Equipment Tests Sewer Catch Basins. By A. H. Miles, pp. 99-100.

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4. Getting Material to Beautify the Plant. By C. K. Calvert, pp. 124-129, 139.
5. Copper and Its Alloys for Sewage Treatment Works. By R. S. Burr, pp. 130-131.
6. *p.* Sanitation in the North Atlantic States. By S. M. Ellsworth, pp. 132-134, 139.
7. Detroit's $20,000,000 Treatment Plant to Eliminate Pollution Problem. By L. J. Lenhardt, pp. 137-138.
8. Chicago's Sewage Treatment Program Continues to Maintain Schedule, pp. 138-139.

M *Canadian Engineer*
March 17

1. Thames River Intercepting Sewer at London, Ont. By L. F. Roberton, p. 13.

March 31

2. Developments in the Chemical Treatment of Sewage. By A. M. Buswell and J. G. Burtle, pp. 11-12, 14.

Details of Constructing Cement-Bound Macadam

C. R. Wightman

By C. R. WIGHTMAN
Director of Public Works, Benton Harbor, Mich.

ESTIMATES were prepared in the Spring of 1935 for about 4 miles of paving under the FERA set-up. The cost of materials, the wages of key men, such as foremen, mixer men, and finishers, and the necessary truck hire, was to be charged to the frontage of the property pro-rata. Later on, using the WPA set-up, new projects had to be formulated. In these, 15 per cent of the material costs and 50 per cent of the truck hire were included in the Federal contribution and this saving was allocated to the City Street Fund to pay for street and alley intersections.

The special assessments were spread over a period of ten years, deferred payments bearing 5 per cent interest. Bonds anticipating the special assessment payments were issued and sold at a premium.

We started out using FERA labor to do the excavating, but as the city was then paying the cost of trucks, we found that the excavating costs were running over our estimates, even with free labor, due to the low factor of efficiency of FERA labor. It was costing us from 15 to 30 cents per cubic yard to do this excavating. To reduce this cost a ⅜-cubic yard gas powered shovel was purchased, with the result that we are now handling this excavating at a cost of from 6 to 10 cents per cubic yard.

The organization on our work is substantially as follows: For heavy grading, we use a ⅜-cubic yard gas powered shovel and from 6 to 10 trucks, depending upon the length of the disposal haul. The operator of the shovel is a regular employee of the Department of Public Works. On this work we also have a city foreman who looks after the grades and 2 or 3 WPA employees for handling mats and incidental work around the shovel.

The form setters consist entirely of WPA employees, usually 6 or 8. Then come the fine graders, headed by a regular department foreman, with from 10 to 14 WPA employees and the necessary trucks to prepare the sub-grade to receive the aggregate.

Next we have the stone gang, headed by the raker, who is also a regular department employee, and aided by 3 rakers from the WPA ranks and 2 or more laborers to do the dumping. As a truck is dumped, it moves forward, spreading the stone as nearly as possible to the proper depth. The rakers then rake the stone to a template moved along the forms by 2 WPA employees. Following this template comes the tamper. This tamper, which consists of a 6-inch I-beam, approximately 12 feet long and fitted with plow handles, is handled by 2 WPA men. It weighs approximately 180 pounds.

Following the longitudinal tamper, a template consisting of two 2 x 6 planks, shod with 2 angle irons, manned by 2 WPA men, is worked transversely. Two WPA men follow closely with forks and rake to correct discrepancies in the cross section. After this tamping, the stone is ready for the grout.

The grout crew is under the direction of a city foreman and consists of a mixer operator, also a department employee, 4 WPA men as broomers, who spread the grout as it is poured on the work and 2 WPA men opening the cement and emptying it on the batch trucks; 2 WPA men with a template tamper similar to the one used on the stone, tamping the grout as it is broomed into place.

These tampers are followed by the finisher, a regular department employee, who, using a wood float 6″ x 48″, fitted with a long handle, floats off the surplus water and corrects any high or low spots, after which he, aided by WPA men, completes the finishing process by dragging the surface with a sheet of burlap drawn along the top with a transverse saw motion.

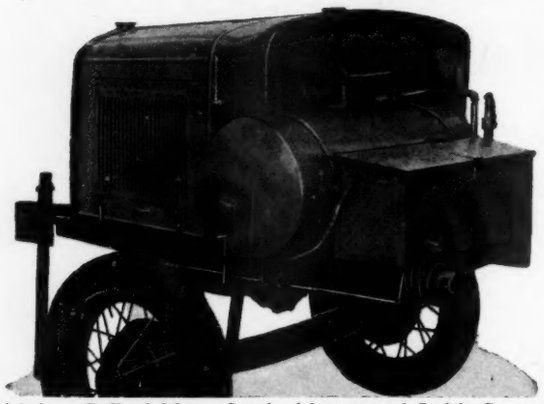
The building of the integral curb follows as closely as possible upon the finishers. A 6″ form is placed on top of the slab form and a wooden face form provided with iron clamps is placed in position, after which the form is filled with a 1-2-3 concrete mix made in a one-sack mixer. After the concrete has been tamped, the wood form is removed and the top of the curb is then formed with a home made tool having the form of the cross-section of the curb.

The curb crew consists of 1 department finisher, 2 finishers from the WPA, 2 WPA men mixing the curb concrete, 2 WPA men wheeling from the mixer to the forms and 2 or more laborers in addition to the men already mentioned, handling forms and doing such work as may be incidental to this curb building. From 10 to 20 common laborers are employed in taking up and cleaning forms and dressing off tree lawns.

After the final finish, if the weather is hot, we cover the slab with about 2 inches of planer shavings and sawdust, which are sprinkled and then we allow from 4 to 6 days for curing. In the fall of the year, leaves have been used in lieu of shavings and sawdust, another Scotch idea, and when there was a possibility of frost, we covered the pavement with marsh hay.

As to details of the construction. The subgrade should be prepared with the same care as if the usual concrete pavement were to be used. In placing the aggregate, we lay only ½ the width of the slab from one end of the street to the other, and in placing stone, we start

Air Compressor *from* FORD PARTS



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midway between two cross streets to obviate the long back up for trucks.

The center form used has a triangular strip 2″ x 2″ bolted to the face side to form a V shaped key groove. The second half of the slab is thus keyed against heaving or settlement.

Care should be taken to keep out fine stone, as it will interfere with the free flow of grout and result in poor penetration. We rescreen all of our aggregate in loading trucks and the fines which are screened out are used for our curb concrete.

For grouting, we use a 14 E mixer with a 21 E drum, using 5 bags of cement per batch. This mixer we equipped with a special discharge to prevent slop over. We also have a drop curtain on the charging side for the same reason. This mixer was formerly equipped with a boom and bucket and we tried to use it in that form, but found that segregation occurred in our grout, and so quit using the bucket and adopted a straight gravity chute. We equipped this chute on the end with a perforated box (part of an oil drum) with ¾″ holes, 2½″ centers on the bottom and 2 rows of holes around the side. These we found undesirable, consequently we plugged them with wood plugs.

A piece of ⅛-inch steel, approximately 24 inches square, with a hinged handle, somewhat like a snow shovel, is used under the grout box, to break the force of the discharge and thus obviate the displacement of the aggregate. We also use a mat of ¾-inch mesh hardware cloth, about 8 x 12 feet, wired to an iron frame of ½ inch round iron. This mat makes it much easier properly to broom the grout into place without displacing the stone.

We also sprinkle the aggregate lightly before grouting. The grout top finish should be kept as thin as possible without exposure of the aggregate.

Expansion joints consist of two thicknesses of ½-inch Celotex, 6 inches deep, previously dipped in cut back asphalt and placed every 50 feet. These are placed by digging out the stone after it has been placed, and this is then replaced by hand.

One of the most essential considerations is the fluidity of the grout. The proper consistency of the grout is determined by the use of a standard flow cone. This cone is 7 inches in diameter at the top, the vertical walls are 3 inches, and the altitude of the cone is 7½ inches. The orifice is a brass pipe 1½ inches long and ½ inch internal diameter. This cone is filled level full and after 5 seconds the orifice is opened and the flow is carefully timed with a stop watch. With aggregate ranging from 1½ inches to 2½ inches, we find that grout of ideal fluidity will empty the cone in 20 to 23 seconds. We find that a water ratio of from 6 to 6½ gallons per sack of cement will produce this result.

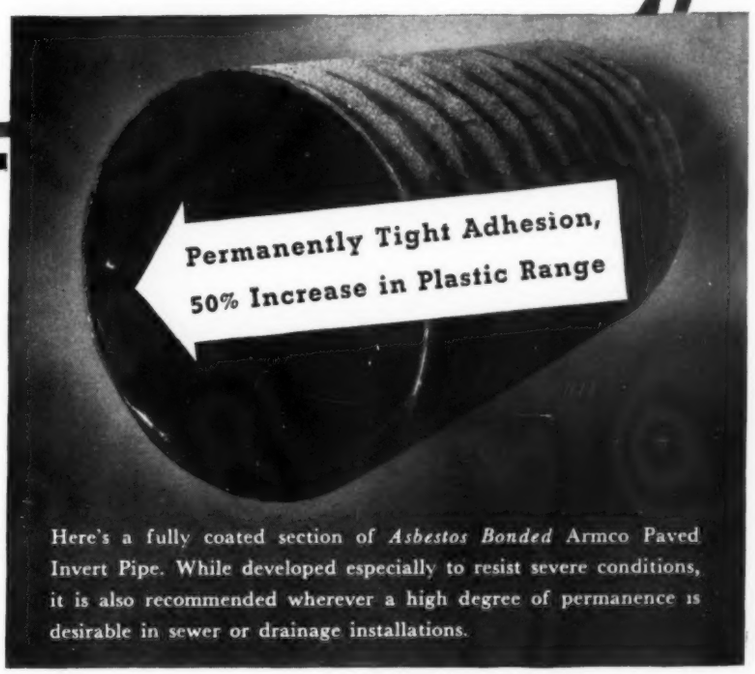
For a 5½ inch slab such as we have been laying, the materials required per square yard of paving, including the curb, are:

Cement—.2016 barrels
Gravel—.2001 tons
Sand—.0569 cubic yards

This is approximately 5 square yards of pavement grouted per barrel of cement. The cost of the curb on our work is just a little less than 6 cents per lineal foot. On 16 projects built last year, the front foot cost to property owners ranged from $1.47 to $2.45, depending upon amount of excavation and storm sewers required. The average of the 16 projects was $1.80 per front foot.

This article is extracted from a paper at the 22nd Annual Purdue Road School.

NOW... an Improvement IN SEWER PIPE That Will Add Years To Its Life



Here's a fully coated section of *Asbestos Bonded* Armco Paved Invert Pipe. While developed especially to resist severe conditions, it is also recommended wherever a high degree of permanence is desirable in sewer or drainage installations.

Ten years of service has already proved the value of putting a *smooth* bituminous pavement in the bottom of corrugated metal pipe. Moreover, in practically all of the installations inspected, these pavements are giving complete protection to the underlying metal.

Nevertheless, Armco engineers have been constantly striving to improve this product, to make it serve your needs still better. And now, after many years of research, they have found the answer in an entirely new process, called *Asbestos Bonding.*

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In addition, tests show that Asbestos Bonding actually widens the plastic range of the coating and pavement *as much as 50 per cent.* This provides an extra factor of safety, especially in storing and handling the pipe. Moreover, with these two improvements—enduring adhesion, plus a wider plastic range—it is obvious that the service life of the pipe will be greatly increased.

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PW-5

Following is a digest of the important articles published last month having to do with water works design, construction and operation and water purification, arranged in easy reference form.

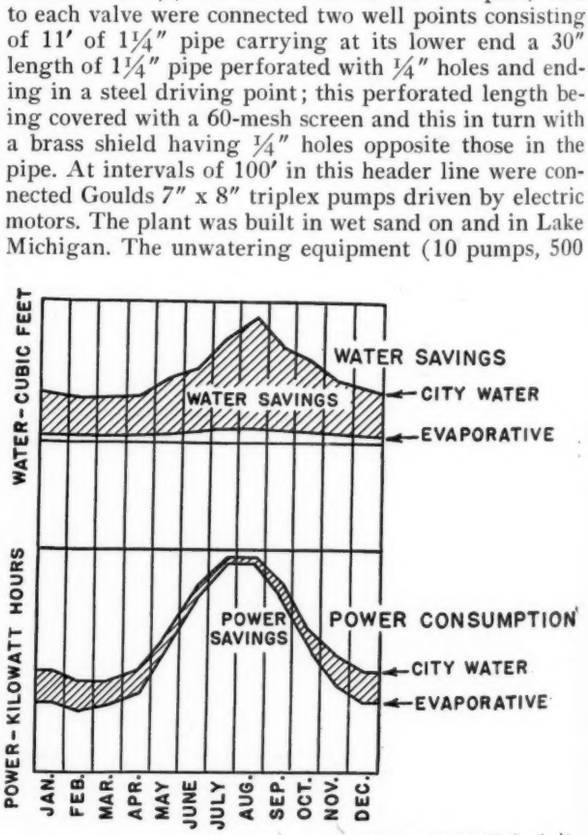
The Water Wheel

Colon-aerogenes determination by the "Standard Methods," from the viewpoint of a trained technician interested in determining only the pressure or absence of the group, is cumbersome and time-consuming. "From the viewpoint of the plant operator the procedure is not only cumbersome and time-consuming, but also subject to error. . . . Three forms of errors were found in the Standard methods (1933 procedure). These were as follows: 1. The failure of the eosin-methylene blue agar to grow the colon-aerogenes group. 2. The fishing of typical and atypical colonies from eosin-methylene blue agar to lactose broth confirmation tubes. 3. In the carrying through of spore-forming lactose splitters to the lactose broth confirmation test, 192 tubes were classified, but in some instances the organisms were of the colon-aerogenes group rather than spore-forming lactose splitters." For some time at Michigan State College the following procedure has been used with satisfaction: 1. Planting of the sample in lactose broth fermentation tubes. 2. Transferring by platinum loop all tubes showing gas to 2% bile brilliant green broth. 3. Reporting all samples positive that produce gas in this broth. This procedure was tried out by 11 bacteriologists in Michigan filter plants, with such encouraging results that the committee believes that the shorter time required, elimination of the human factor and more accurate results obtainable recommend it for adoption as the required procedure in Michigan water treatment plants. It will be included in the next edition of the Standard Methods.[A22]

Air conditioning employs water for cooling the air in summer, the cooler the water the less required. At average temperature, there is a maximum demand of 40 gal. per capita per hour for residences, 47 for offices, 20 for restaurants, etc., with a load factor of 30 to 60; or an average of 350 gpd per capita during the warm season. But if evaporative condensers are used, 5% of this amount may be enough. Economic considerations and restrictive regulations in New York City led to use of evaporative condensers on about 60% of the installations. Even this gives a consumption of 140 gpd per capita of those for whom air conditioning is provided at some one place—home, store, or theatre, etc. If provided in all buildings it would be about eight times that. However, if air conditioning doubles every four years from 1936, in about 12 years the maximum rate will be 35 gpd based on the entire population with 60% use of evaporative condensers, or an average rate of 5 gpd.[A12]

Well drilling regulation is secured by a state law of Wisconsin—believed to be the first such law in the United States. It aims to insure proper location, construction and finishing of all wells used for human supplies and proper installation of pumping equipment. The preparation and enforcement of rules and regulations are entrusted to the State Board of Health, which has created a Division of Well Drilling Supervision. A supervisor of well drilling was selected by civil service examination. Before preparing the rules and regulations, a conference was held with the officers of the well drilling industry in the state, state geologist, state engineer, etc., and a committee appointed by the well drillers prepared a rough draft of suggested regulations, which was submitted to a conference of 75 well drillers and manufacturers of materials and equipment which lasted for two days, and all attending were asked to send to the health board further suggestions and criticisms; all of which were considered in preparing the regulations. A second draft was made and submitted to a select group of well drillers and others; and it was proposed to present a final draft at a public hearing. About 450 to 500 well drillers will be affected.[W1]

Unwatering ground for construction of the filter plant at Hammond, Ind., necessitated lowering the ground water 12 ft. inside an area 150′ x 180′ for the pumping station, and one of 250′ x 255′ for the filtered water reservoir. At each site the contractor surrounded the area with 3″ header pipe in 20′ lengths, with a 3″ gate valve at one end of each section. Each section contained five 1¼ in. tees and valves 4′ apart, and to each valve were connected two well points consisting of 11′ of 1¼″ pipe carrying at its lower end a 30″ length of 1¼″ pipe perforated with ¼″ holes and ending in a steel driving point; this perforated length being covered with a 60-mesh screen and this in turn with a brass shield having ¼″ holes opposite those in the pipe. At intervals of 100′ in this header line were connected Goulds 7″ x 8″ triplex pumps driven by electric motors. The plant was built in wet sand on and in Lake Michigan. The unwatering equipment (10 pumps, 500



Journal, Am. Water Works Ass'n.

Water conservation made possible by use of evaporative condensers for air conditioning.

well points, pipe and fittings) cost about $50,000. The complete plant for this $403,000 contract cost more than $125,000. About 12,000 cu. yd. of high-strength, low-slump concrete was placed between May 10 and Dec. 1, 1935.[83]

A river crossing under the tidal River Foyle, in northern Ireland, was constructed of two parallel lines of 12″ steel pipe without having to make any joints under water. The pipes were made in 20′ lengths, and bolted into 80′ lengths, except two 100′ lengths at the deepest part. Each length had a ball and socket joint allowing an angular movement of 30°. Two 80′ lengths were placed side by side on shore, connected by steel cross links, a blank flange fastened at each end, and barrels attached by ropes to float them. At high tide (there was a 7½ ft. tidal range) they were floated, towed into position, and the landward ends attached to the river ends of the previously laid pair of pipes, which had been held at the surface by pontoons. When this ball and socket joint had been made, the barrel floats were moved to the forward end of the new section and the joint allowed to settle to the river bed, the forward end of the new section being supported at the surface. The pontoon was moved to this end, a new section of pipes towed into position and joined with a flexible joint and the process repeated. A dredge just ahead of the pipe laying prepared a trench for the pipe.[D2]

Bibliography of Recent Water Works Literature

c, Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

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12. Air Conditioning in Relation to Water Consumption. By L. L. Lewis, pp. 318-329.
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14. Statistical Comparison of Water Departments of Wisconsin Cities. By E. W. Moke, pp. 342-355.
15. Specifications for Water Main Construction. By A. R. Davis, pp. 356-360.
16. Deep Well Pumping. By C. N. Ward, pp. 361-368.
17. Meter Shop Practice. By M. B. Cunningham, pp. 369-378.
18. Factors in Making Rates. By M. C. Nichols, pp. 379-388.
19. Utility Accounting Methods. By R. E. Lee, pp. 389-401.
20. Distribution System Maintenance. By H. Magnus, pp. 402-405.
21. Trunk Line Pitometer Survey. By L. N. Thompson, pp. 406-410.
22. Standard Methods of Water Analysis and Two Percent Bile Brilliant Green Lactose Broth Confirmation. By W. L. Mallman, pp. 411-420.

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March

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D — *The Surveyor*
April 3

6. *p.* Scraping of Water Mains. By A. A. Fulton, p. 501.
7. *p.* Underground Water Supplies. By G. A. Cumming, pp. 503-504.

E — *Engineering News-Record*
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6. Control of Micro-Organisms in the Albany Water Supply, p. 487.
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13. Flood-Damaged Water Systems Quickly Replaced in Service. By N. N. Wolpert, pp. 370-373.
14. *p.* Required Fire Flows in the Water System. By P. C. Charnock, pp. 393-394.

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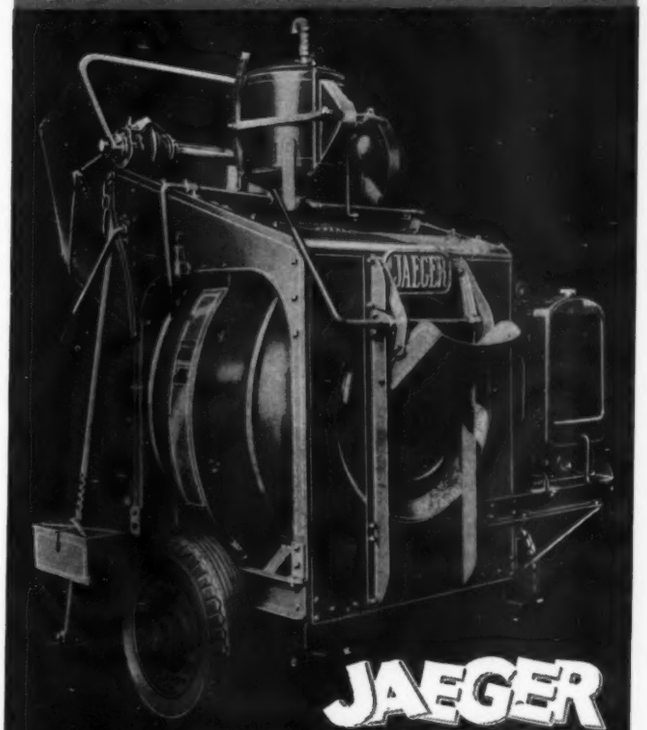
2-BAG BRIDGE BUILDER



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16. *p.* Recent Trends in Water Works Design and Operation. By L. R. Howson, pp. 428-432.
16. Lime Slaker Requirements Based on Operating Results and Tests. By H. O. Hartung, pp. 433.
17. Laboratory Control: Mineral Constituents of Water. By C. R. Cox, pp. 437-438.

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4. *n.* Second Large Elevated Tank Balances Evanston Water System, pp. 63-64.

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18. *p.* Corrosion Problems in Municipal Water Works. By W. E. Patterson, pp. 37-38. By J. G. Duncan, p. 38.

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3. *c.* Well Points Drain Sand Foundation of Hammond, Ind., Filtration Plant, pp. 50-53.

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Atmospheric Reaeration of Flowing Streams

Atmospheric reaeration of relatively shallow flowing streams of water was studied at the Cincinnati Stream Pollution Investigations Station of the U. S. Public Health Service and the following conclusions (among others) reached: The rate of reaeration of a body of water is governed primarily by the rate of absorption of atmospheric oxygen at the water surface, and secondarily by the volume of water and its temperature, depth and relative degree of agitation. The rate at the surface appears to be influenced by the temperature, oxygen saturation deficiency, and surface agitation of the underlying water, but not by its volume. The effective oxygen saturation deficiency of a relatively shallow flowing stream may be measured with a fair degree of accuracy at a point below the surface or even at mid-depth, owing to the vertical circulation. The mean velocity of flow of the underlying stream exerts a powerful influence on the surface rate of reaeration; which, however, is much less below a certain critical velocity, which was about 10 ft. per minute in the streams studied.

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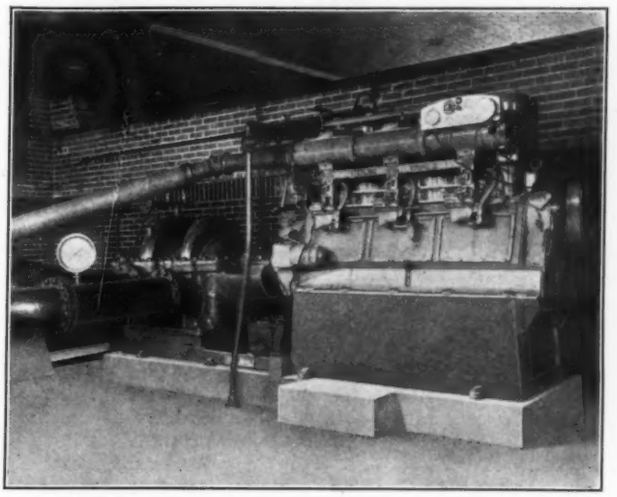

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DRESSER COUPLINGS

When you need special information—consult the *classified* READERS' SERVICE DEPT., pages 67-69

Water Supply and Sewage Treatment for Summer Camps

THE annual rush to summer camps will soon be in full swing. Many camps will need repairs, additions or improvements to their water supply or waste disposal facilities. City engineers, water works superintendents and others are frequently called on for advice, and to prepare plans for necessary work. This material is prepared to acquaint them with suitable methods and materials. If you want further information, write the editor of PUBLIC WORKS.

Water Supply

ASSUME that all surface waters, waters from shallow wells, and most springs are dangerous, through either constant or occasional contamination. Bacteriological analyses, unless backed by a sanitary survey of the watershed, and unless they cover a considerable period of time, should not be used as a measure of the safety of the supply. A single analysis is valueless. There is not necessarily any connection between the appearance of a water and its safety. Many fine, clear springs are badly polluted. Every supply which is subject to occasional pollution should be treated *continuously*.

In selecting a supply, first consideration should be given to its initial purity. It is better to go to more expense to provide a supply, such as a deep well, than to provide a supply easier to get, though unsafe, and then depend on treatment. If local ground conditions are favorable, and the well and casing properly constructed, the deep well may be the safest supply.

The next best source of supply is often a shallow well or a carefully protected spring. Such supplies should be regarded with suspicion and should be disinfected as a matter of precaution. All surface supplies, that is supplies from brooks, streams, rivers or lakes, should be disinfected continuously and if there is evidence of any more than occasional pollution, thev should be filtered as well. A supply known to be continuously or frequently contaminated should be abandoned.

A supply perfectly safe bacteriologically but which is unpalatable due to bad tastes or odors is still a dangerous supply, indirectly, because it will drive the consumers to other, better tasting sources which may be grossly polluted. No supply should be regarded as safe if it is unpalatable.

Satisfactory treatment for these small supplies has presented a problem. The difficulty of handling chlorine gas, the cost of apparatus, the instability of chloride of lime, and the lack of dependable hpyo-chlorite feeders have been among the chief problems in this important field. We have a different picture today. Probably the largest single factor in this change was the introduction of calcium hypo-chlorite with an available chlorine content of around 70%, and in a stable and readily handable form. This provided a substantial base from which to attack the problem anew. We have an entirely new technique in the treatment of these small supplies. Six years ago the least expensive dependable machine for this purpose was a manual control unit which required a prepared solution. Today a better and more convenient apparatus can be obtained for less than half the price. The requirements for apparatus will vary with the supply being treated. Some descriptions of apparatus are listed hereafter. These are offered as a general guide. All types listed have their uses but none is so versatile as to handle all jobs. Pick the one which best meets your requirements at least cost.

Some manufacturers have a staff of trained representatives who will visit the job, prepare recommendations, and supervise the installation of the equipment; they are available subsequently also for needed service. This, of course, increases the cost of the apparatus but is often highly desirable. Other manufacturers market their equipment in less costly but fully satisfactory methods.

General Recommendation

1. The apparatus should be simply designed and constructed, so that the principles of operation can be understood by the non-technical men who will operate it. The various component parts should be accessible for ready repair or replacement.

2. The apparatus should be constructed of materials resistant to the chemicals which it is desired to feed.

3. The apparatus should have a record for dependability. Visibility of feed is desirable. Apparatus subject to stoppages is worse than none. Feeding from the bottom of the supply tank or from the surface of the liquid tends to clogging and stoppage.

4. The flow of solution should be in proportion to the flow of water being treated, or (if the supply is pumped by a constant feed pump) the apparatus should be arranged to start automatically when the pump starts and stop automatically with the pump.

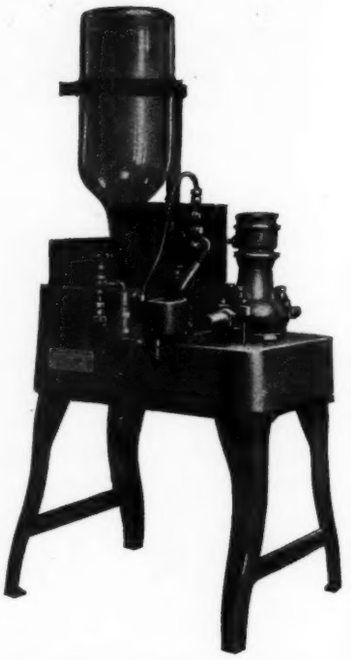
5. The apparatus should be installed in duplicate, or an adequate supply of spare parts must be provided so that repairs can be made quickly.

6. Apparatus depending upon electricity for its operation should not be considered unless the same source of power is used to pump the water.

7. A dependable testing apparatus should be provided, with instructions for its operation, so that the presence or absence of chlorine in the treated water can be determined readily.

8. The apparatus should be provided with a simple and quick means of changing the dose without the necessity of shutting down.

10. The apparatus should be designed so that special solutions are not needed for its operation. It should be able to handle ordinary settled hypo-chlorite solutions and commercially available bleach liquor.



The Wallace & Tiernan Chlorometer

The Chlorometer

Manufactured by Wallace & Tiernan Co., Inc., the chlorometer is actuated by the water supply being treated and proportions its feed exactly with this flow. There is added to a standard water meter, an auxiliary train of gears with a "take-off" shaft, one end of which carries a disc, which revolves with its lower edge in the solution being fed. Small holes are drilled in the periphery of this disc which fill with solution when submerged. As the holes in the disc line up with a small hole in a take-off block, each in its turn is relieved of its small charge of solution.

The Chlorometer is really a proportional feeder and when operated properly is very accurate. If the supply being treated is pumped, the solution can be delivered to the pump suction, utilizing the pressure from the pump discharge to operate the injector, but if the apparatus is hooked into a pressure line, it is necessary to provide a small pump

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to build up sufficient pressure to operate the injector. The pressure required is at least three times the pressure at the point of application. Change in dose is accomplished by changing to another disc with larger or smaller openings, or changing the strength of the solution being fed.

Phipps & Bird Solution Feeder

Manufactured by Phipps & Bird, Inc.; this feeder is designed to feed accurately small amounts of any corrosive solution. It is a gravity type feeder but a solution pump can be furnished when it is desired to inject against pressure.

The chlorine solution flows by gravity from a supply tank to a glass container box where, by means of a small float valve, a constant level is maintained. A glass siphon takes the solution from this constant level box to an outlet funnel and thence by gravity to the point of application or to the solution pump. The rate of flow is easily adjusted by raising or lowering the outlet or discharge leg of the siphon.

This apparatus is constructed principally of glass and rubber to resist corrosion. It is well designed and can be disassembled easily for cleaning or repair. It is of especial value where the flow of water is uniform, as in pumping.

The "Stirred Feeder" uses small agitators to prevent suspended solids from settling out. It is designed for feeding milk of lime or chloride of lime. It is not well adapted to the average camp water supply problem but might find an application in sewage treatment.

This company sells directly to the consumers usually, but sometimes through agents. Complete and comprehensive instructions and drawings are included.

The Chlor-O-Feeder

Manufactured by Proportioners, Inc.; reduced to its simplest form the Chlor-O-Feeder is a positive displacement diaphragm type pump, designed to pump corrosive chemicals in very small amounts. The pump is actuated by a reciprocating water engine directly connected to the pump. A water meter or rotor in the water supply line actuates a unique valve linkage on the water engine which causes the engine to operate the pump in exact proportion to the flow of water being treated. The chemical can be fed into a line under considerable pressure without any outside source of power. Other sources of power can also be used.

The chlorine solution is mixed in a suitable small tank, the suction line from the feeder draws from this tank. When treating a supply pumped with an electric pump, the feeder can be operated by a small electric motor which is connected up with the pump motor. The feeder then starts and stops with the pump automatically.

Chlorinators

Manufactured by Wallace & Tiernan Co., Inc. and The Pardee Engineering Co.; a Chlorinator is a device which will maintain any predetermined rate of flow of chlorine gas, or in an automatic machine, any predetermined dose of chlorine, indicate its rate of flow and deliver it into the supply being treated. Even the smallest chlorinators are too large for use on the water supplies of small camps. Two general types are available, the direct feed (sometimes called dry feed) which delivers the gas directly to the supply, and the solution feed type which first mixes the chlorine with a small supply of water and delivers the resulting solution.

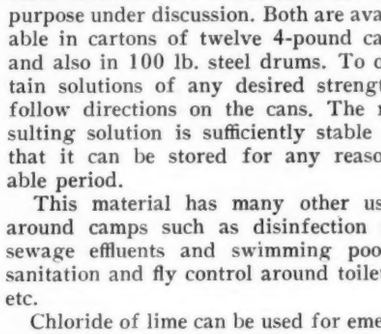
Proper installation is essential; all successful chlorinator manufacturers make a careful survey of the conditions to be met before offering any apparatus and furnish experts to supervise the installation and to train the operator. If your supply warrants the use of a chlorinator, consult a manufacturer of this equipment and be guided by his recommendations.

Chemicals Available

Two products of exceptional merit for camp use are "H.T.H." made by the Mathieson Alkali Works and "Perchloron" made by the Penna. Salt Mfg. Co. Containing about 70% available chlorine and being stable over long periods, these materials are about ideal for the purpose under discussion. Both are available in cartons of twelve 4-pound cans and also in 100 lb. steel drums. To obtain solutions of any desired strength, follow directions on the cans. The resulting solution is sufficiently stable so that it can be stored for any reasonable period.

This material has many other uses around camps such as disinfection of sewage effluents and swimming pools, sanitation and fly control around toilets, etc.

Chloride of lime can be used for emergency sterilization jobs where the above are not available. It can be purchased in most grocery stores. It loses strength with age and when solutions are made with it, large amounts of sludge are produced. Considerable lime is left in suspension which may clog the feeder.



The Phipps & Bird Solution Feeder

One exception to this is the "Stirred Feeder," made by Phipps & Bird.

Laundry bleach solutions are available in 5-gallon glass bottles at most laundry supply houses and is good or bad depending on the care used in making it. It loses strength with age and lack of proper storage conditions, consequently its exact strength is never known. It can be used with good results only under proper supervision.

Chlorine gas is obtained in steel cylinders containing 100 to 150 lbs. In buying, be sure that the purpose for which it is to be used is stated. Among the companies supplying gas for this purpose are, Mathieson Alkali Works; Electro Bleaching Gas Co.; Penna. Salt Mfg. Co.; Solvay Process Co.; Great Western Chemical Co.; Monsanto Chemical Co., etc.

Electro-Katadyn

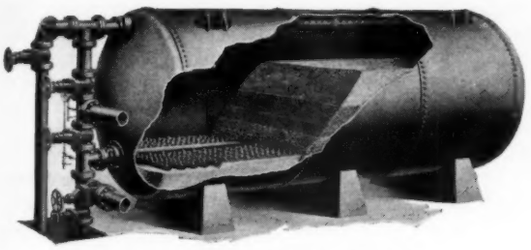
Manufactured by the Katadyn Process Corp.; this apparatus, a newcomer in this country, operates on the principle that small amounts of ionic silver produce a powerful germicidal action. The water being treated passes through a rubber lined chamber containing the pure metallic silver electrodes, through which a very small low-voltage current passes. An automatic switch changes the polarity regularly to prevent polarization. A control panel is furnished on which is mounted an ammeter to indicate rate of treatment and a rheostat to control it. The silver electrodes will last for several seasons. This apparatus is simple to operate and should be fairly free from operating troubles. An overdose of the silver will not cause objectionable tastes.

This company also makes a porous stone filter suitable, perhaps, for the smaller camps. In the Katadyn filter the conventional porous stone is used but the core is filled with "silver Sand." This, it is claimed, keeps the stone sterilized and prevents the growth of bacteria which tends to occur in filters.

There are certain factors which govern the size and type of Electro Katadyn used which will have to be gone over carefully before any apparatus is installed. This can be done in some cases by correspondence but generally requires an inspection by their representative. This restriction does not hold for the small sterilizing filter.

Water Filters

Filters are used as an added safeguard, and also to improve the physical quality of the water. Slow-sand filters have practically no place in this work. With "rapid" or "mechanical" filters, a coagulant, usually alum, is added to the water to produce a "floc," which, as it settles, removes much of the suspended matter and most of the bacteria. Some particles of the floc do not settle out; these are retained on the sand bed of the filter forming a mat. In passing through the filter the water is strained through this mat, removing practically all of the remaining impurities. When the meter becomes dirty the floc and retained im-



Phantom view of Pressure Filter

purities are removed by "back-washing," that is, running a flow of water through the filter in a reverse direction.

There are two general types of rapid sand filters, gravity and pressure. Gravity filters are open on the top and the water flows down through the sand to the clear water well by gravity. Pressure filters are built in steel tanks and as the name implies, the water is forced through by a pump or by the hydrostatic head in the line. Where water is pumped, pressure filters require only one pumping where a gravity filter will usually require two. Pressure filters are generally very adaptable to camp water supplies.

In these, the sand bed consists of 2 feet of small sized sand, supported by a layer about one foot of graded gravel which in turn rests on a pipe grid which covers the entire filter bottom. The grid acts as a collection system for the filtered water which leaves the bottom of the tank through a single outlet. When the filter becomes dirty, it is washed by reversing the flow of water by means of valves..

These filters, which have a capacity of about 2½ gallons per square foot per minute, aid materially in clarifying the water, but they cannot be relied on to provide purification. The water should always be chlorinated.

Filters are usually installed in batteries of three. The reason for this is that the back wash rate is about four times the filtering rate and sufficient water to wash properly one large filter is seldom available, whereas if only one of these is washed at a time, the amount of water needed is only one-third as much. When the job is laid out, make sure that sufficient wash water is available. Three small filters seldom cost much more than one large one, and sometimes less. Provide sufficient filtering area so that it will not be necessary to filter at a rate higher than 2½ gallons per sq. ft. per min. Filters will work faster but at a sacrifice in the quality of the water.

If it is only necessary to remove small amounts of turbidity, a simple alum feeding tank ahead of the filters will usually suffice. Introduce the disinfecting solution into the filter discharge line but leave provision for its application ahead of the filter also. Also make provision for chlorinating the wash water supply, in case it may be necessary to control growths in the under drain system.

If it is necessary to remove more turbidity and small amounts of color or tastes and odors, provide a settling tank ahead of the filters. Adding "Nuchar" or using "Black Alum" (a mixture of alum and activated carbon) will aid in taste and odor control.

Where considerable turbidity and contamination must be removed, a carefully designed filter plant will be needed, and able advice should be obtained.

Filters suitable for most of the problems of camp water supply can be obtained from the following companies; most of them provide expert technical assistance on filtration problems: The Roberts Filter Co.; Everson Filter Co.; The American Water Softening Co.; The Graver Tank Mfg. Co.; Norwood Engineering Co.; International Filter Co.; E. W. Bachrach & Co.; W. B. Scaife & Co. Additional data will be forwarded on request to the Editor.

Sewage Treatment for Summer Camps

THE capacity of the sewage treatment plant for a summer camp must be based on the amount of water that is used. In few camps is there any record of this. Data may sometimes be obtained, when the water is pumped, from pump capacities and hours per day of operation; sometimes from other sources. The New York State Department of Health estimates 25 gallons per person per day. This should be the minimum; 35 to 50 gallons per day is usually better. On the other hand not much excess capacity is needed. Camps operate normally in July and August only, and these are the most favorable months for sewage treatment.

Methods of Treatment.—Tank treatment, followed by subsurface disposal or treatment in trickling filters or contact beds, and final chlorination, usually meets all requirements of treatment. For installations having a flow of less than about 5,000 gallons per day, a small septic tank is generally best and most economical; and there have been many satisfactory installations of these tanks up to 30,000 or 40,000 gallons daily flow. Subsurface disposal, even with favorable soil conditions, will generally be limited to about 5,000 gallons per day. For larger jobs, the small Imhoff tank, with trickling filters or contact beds, provides an economical and satisfactory treatment. Chlorination should be provided for the effluent from these installations.

Tank Treatment

Septic Tanks.—The commercial metal septic tanks are strongly recommended for jobs up to and including 500 gallons per day, though concrete tanks built in place should be no more costly, and when well designed give equally good service. The metal tanks are usually made of Armco iron or copper bearing steel, and are given additional protection by a heavy bituminous coating. There is no question of their durability under all usual conditions of service.

Use no tank of less than 300 gallons capacity. Up to flows of about 1500 gallons per day, provide a detention capacity of 16 to 20 hours. For larger sizes, reduce this so that, for a flow of 5,000 gallons per day, a tank capacity of about 2500 gallons is provided; for larger tanks, a further reduction to 8 to 10 hours detention is permissible. For a flow of 10,000 gallons per day, the tank capacity should be from 4,000 to 4,500 gallons.

A built-in-place tank of concrete to provide this capacity should be about 5 feet deep below the flow line, 6 feet wide, and 20 feet long. Freeboard should be about 15 inches; the tank should be covered with concrete, with manholes at both ends. Baffles, placed 18 inches from the inlet and outlet, should extend 6 inches above and 18 to 24 inches below the flow line, or use a "T" at the inlet, as shown in the illustration.

Imhoff Tanks. — While the 2-story tank is satisfactory in small installations, it is seldom economical with flows of less than 10,000 gallons per day, and generally not for flows considerably in excess of this. The illustration herewith shows desirable design features for a tank to handle a flow of 35,000 gallons per day. A detention period of 4 hours should be provided in the flowing-through chamber, and storage capacity of 2 to 3 cubic feet of sludge per person should be available. All slopes should be 1:1 or steeper; the sludge discharge pipe must be at least 6-inch; the scum chamber area should be about 30% of the surface area of the tank.

Plant Location.—While it is desirable to locate the tank as far away as possible from the camp buildings, and preferably out of sight, it should not be placed so low that the secondary treatment devices will be handicapped by wet ground or flood waters. When subsurface disposal is employed, it is especially necessary that the underground lines be kept well above ground water, preferably on the slopes of a hill; at least on fairly high ground.

Choose also a location where prevailing winds, if any, will not blow possible odors toward the camp or toward other buildings or toward heavily used facilities of the camp. Locate the plant so that final discharge of the effluent will not interfere with the present use of any stream or lake.

Where there are a number of isolated buildings, and the soil is fairly open, these buildings may best be taken care of by individual small septic tanks with subsurface disposal lines or leaching cesspools. In such cases, the installations may be close to the buildings served.

Subsurface Disposal Data

For flows of less than 5,000 gallons, disposal by means of subsurface tile lines is usually best, unless there is rock present, the ground is extremely dense, or the water table is commonly within 3 feet of the ground surface. This method can be used for flows up to 10,000 gallons per day in favorable soils. It should not be used in areas where the water table lies close to the ground surface; and should be used with caution in very tight soils. Leaching cesspools are suitable for small flows and in areas of open soil.

In all but very tight soils it may be assumed that one square foot of soil will absorb 1 gallon of sewage per day. Subsurface lines, for economy, should therefore be constructed as shown in the accompanying illustration. This arrangement provides the greatest soil area for absorption, as compared to the amount of excavation and the length of tile. An illustrative layout to handle 4500 gpd. is also shown.

The tile may be 4-inch, farmer drain or bell and spigot; or better yet, a specially constructed porous wall tile may be used. Joints of course should be left open, but protected above with a layer of burlap or tar paper; with bell and spigot pipe, the lower half of the bell may be broken off. Slope should be not less than 3 nor more than 5 inches in 100 feet; there should be no single runs or lines more than about 125 feet in length; parallel lines should be not less than 6 feet apart, preferably 12 to 20 feet. Lay the tile on a board or other support, as shown, to maintain grade.

With flows of more than 2000 gallons per day, siphons are desirable. No change in the design of the subsurface line, as already described, is needed. Proceed as follows: Determine the footage of disposal line required; compute the capacity of the drain tile; fix the capacity of the siphon chamber at 75% of the tile line capacity. Use a 4-inch siphon for flows up to about 3000 gpd., and a 5-inch or 6-inch up to about 10,000 gpd. Design data for siphons are available on request.

Trickling Filters, Contact and Sand Beds

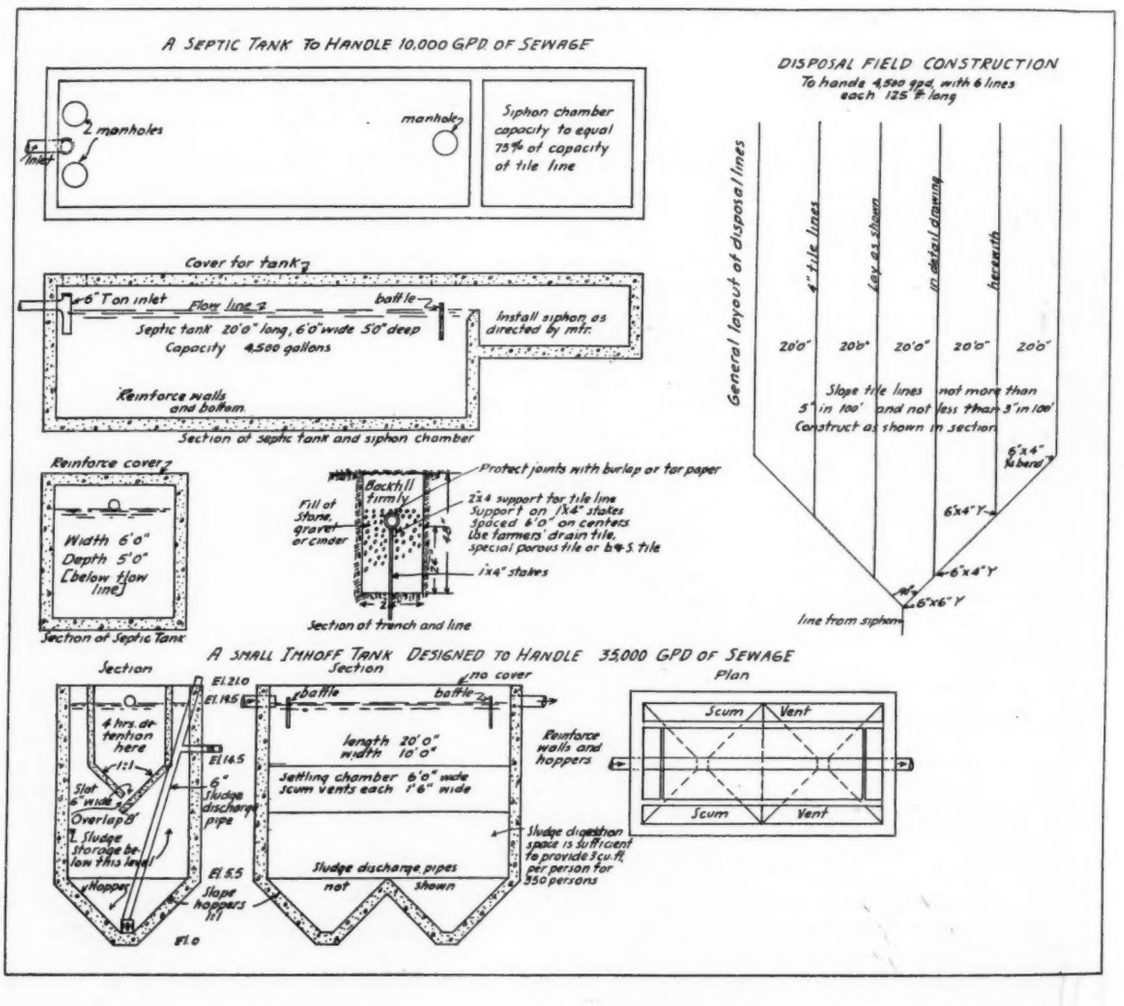
Trickling filters consist of a bed of 1½ to 2½ inch broken stone, 5 to 10 feet deep, over which the sewage is sprayed or otherwise evenly distributed. For small jobs, rotary distributors are much better than spray nozzles. These rotary distributors are made in sizes from 15-ft. diameter up. This size of unit is extremely reasonable in price and will handle flows of 7000 gpd. with a 6-ft. depth of stone, and about 9500 gpd. with an 8-ft. depth. The 20-ft. distributor costs only slightly more and handles up to 12,000 gpd. in the 6-ft. depth. In computing capacities of trickling filters, use 7 gallons of sewage per day per cubic foot of stone.

One rotary distributor and the accompanying filter unit is usually sufficient for camp installations; two small units may be desirable in some cases.

Special siphons are required for these rotary distributors. Data on design of these, and any desired additional information on rotary distributors or on spray nozzles for trickling filters will be sent on request.

Contact Beds.—Despite a number of disadvantages when considered for municipal sewage treatment, contact beds are often very satisfactory for secondary treatment of camp sewage. These consist of stone-filled tanks in which the sewage stands in contact with the stone. The period of filling, standing full, discharge and resting are all controlled by automatic apparatus which operates with almost no supervision. Construction is simple. Control units can be purchased ready for installation.

Contact beds should be designed for a dosage of about 2½ gallons per day per cubic foot of stone. Average depth to underdrains will be 4 feet; if neces-



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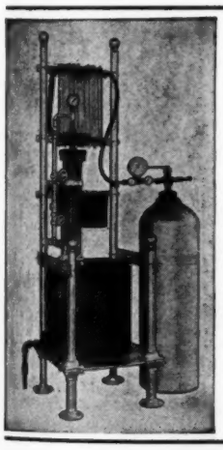

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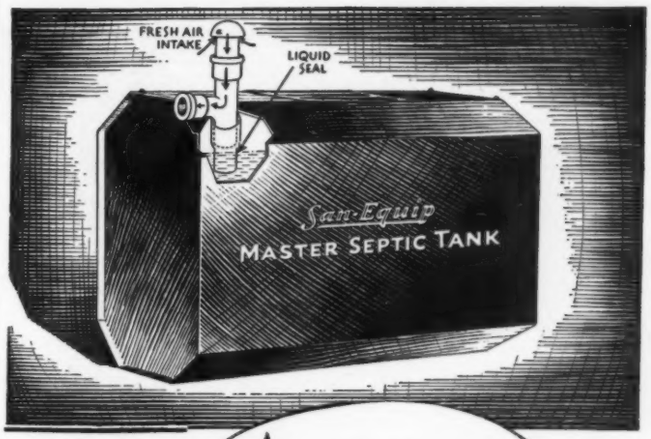

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THIS new-design horizontal tank has liberal working capacities and improved design features. New-type intake minimizes danger of clogging. Intake extension above ground marks location of tank and provides access to intake without digging. House line is automatically vented and sealed against escaping gases. The sectional cover permits inspection and cleaning of the tank without removing the entire cover.

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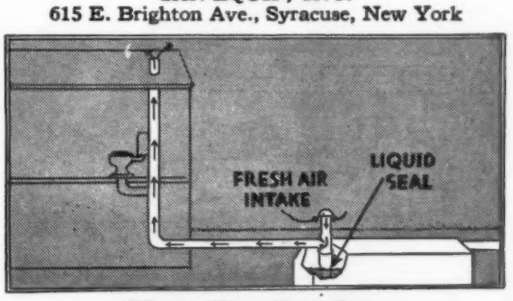


New Top Intake

The top intake of the Master Tank allows the sewage to enter the tank rapidly but without disturbing tank contents—reduces possibility of clogging at this point. Extension above ground provides fresh air intake to house stack. Extension below liquid level seals the line against escaping gases. No other trap or vent is needed. Intake can be reached without digging.

San-Equip
MASTER SEPTIC TANK

When you need special information—consult the *classified* READERS' SERVICE DEPT., pages 67-69

Phantom view of horizontal type commercial metal tank. Full partition forms separate treatment and effluent chambers.

sary to conserve head, 2½ feet is sufficient. Where prevention of odor is important, carry the stone up about 6 inches above the height to which the sewage will rise. When the bed is filled, sewage will not be exposed. Further data will be sent on request.

Sand Beds.—While sand beds give excellent results from the purification viewpoint, they require more attention and care than either trickling filters or contact beds; when used with septic tanks they are especially prone to cause odors. If used, they may be designed on the basis of 2 gallons to 2½ gallons per square foot per day. Siphons are required for dosing. Further details will be sent on request. A variation is covered sand beds. Excavate and lay underdrains at desired elevation, 6 ft. apart. Cover with 36 inches of sand; on top of this lay distributors 6 ft. apart, but midway above drains. Bed these in gravel and cover with soil.

Pumps, Screens, Chlorination

Pumps and Screens.—In a camp installation there should not be much material to be screened out; nevertheless if pumps are to be used, a coarse screen with bars about 1½ inches apart should be placed ahead of the pumps.

When pumps are necessary, it is also necessary to have two sources of power; this may be costly under some conditions, but often the use of gasoline engines will permit such provision at a reasonable cost. Where pumping is necessary all of the time, electric drive is best, with float control of starting and stopping. But where pumping is needed only at times of high water, duplicate air-cooled gasoline engine driven pumps may solve economically the duplicate power requirements. Where possible, it is better to pump the treated sewage than the raw because there is less danger of stoppage or clogging due to rags or other suspended material; and the flow is more uniform.

Chlorination. — Chlorination devices for water supplies for camps are discussed in another article in this issue. Chlorination for sewage can be accomplished with the same equipment, using such larger dosages as may be necessary under local conditions.

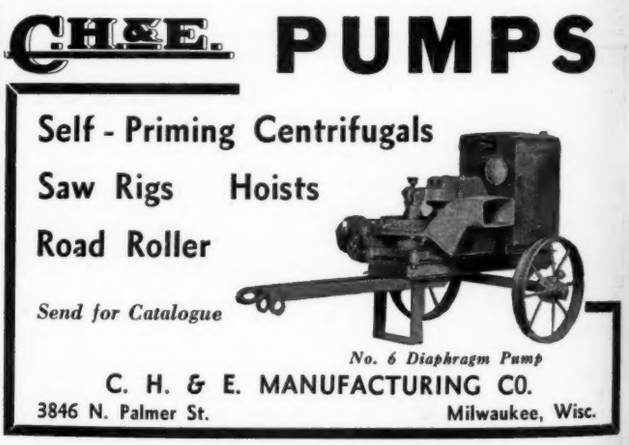
Miscellaneous.—Grease traps should be placed on all lines leading from kitchens; they are also desirable on lines from shower baths or other places where much soap is used.

In most states, plans for water supply and waste disposal must be approved by the State Board of Health. Obtain data on requirements from the Sanitary Engineering Dept. of the Board. In general, plans submitted for approval should be accompanied by a report outlining local conditions affecting design.

Chemical toilets are perhaps the best substitute for sewers where running water is not available. Information on these and other substitutes on request to the editor.

In Asking Information

In requesting information from the editor on any point in connection with this subject, readers are requested to be specific. This permits giving specific and desired data in return.



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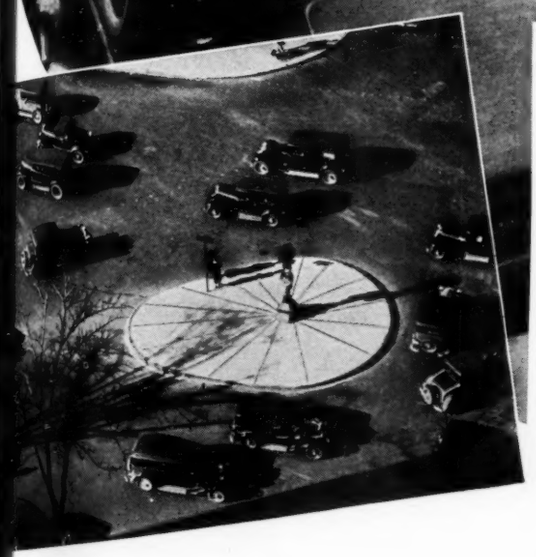

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Drainage, Drainage Structures and Subgrades

By GEORGE GAULT
Wayne County Surveyor, Richmond, Ind.

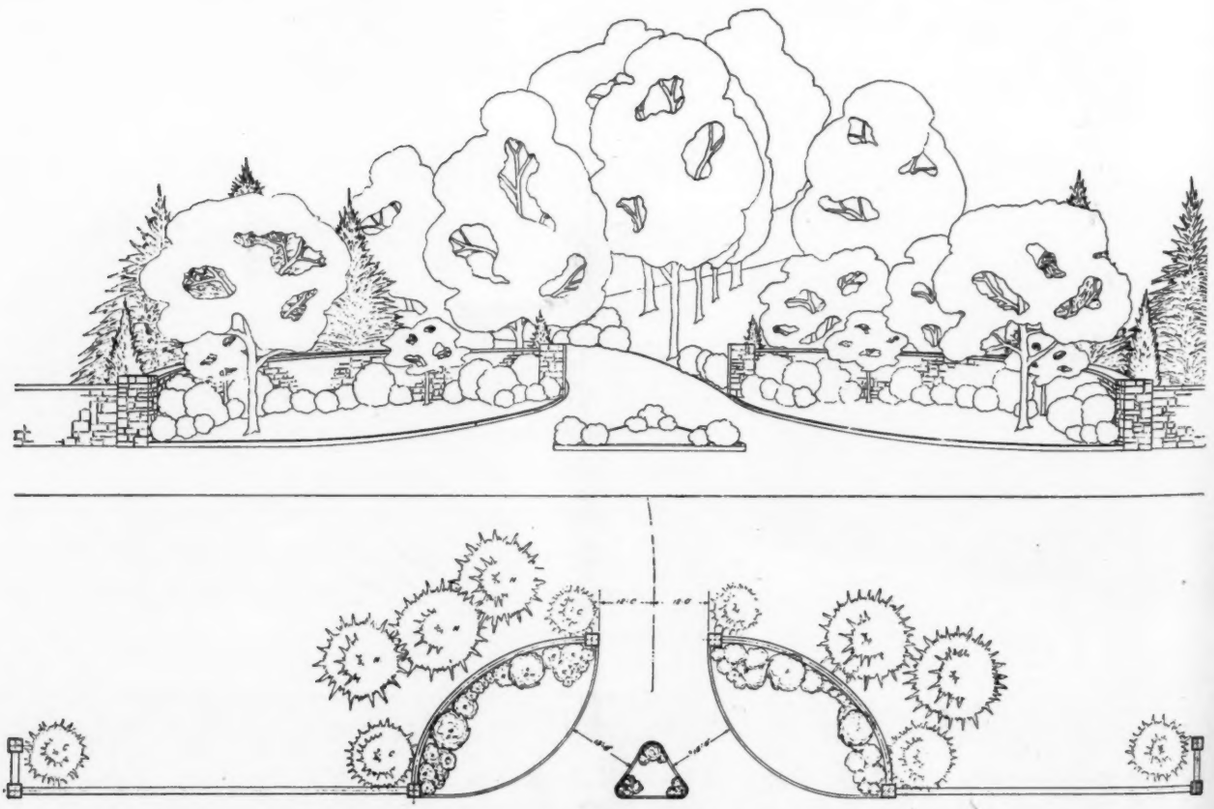
IN PRESENTING a paper before the 22nd Annual Purdue Road School, covering procedures in making "Surveys of Road Conditions Before Resurfacing," Mr. Gault gave the following information regarding his practice in drainage and subgrade work:

Many of our roads have been drained by digging a ditch of a certain width and of uniform depth below the surface of the road without any provision being made for the water to get out of these standard ditches. The result is that the water lies in these low points in the side ditch for a long time after the remainder of the road has dried out. This frequently results in permanent damage to the road surface, and such conditions should be remedied before any resurfacing is done. The width of the road from shoulder to shoulder should be kept uniform but the width and depth of the side ditch should be such that the water will all move to a permanent outlet without damage to the road. If it is not possible to have level stakes set for sloping these ditches it is a good practice to drive over the roads either during or immediately after a heavy rain when the defects in the drainage will be very noticeable; notes can then be made showing the points to be improved by drainage. After the drainage has been completed it is a good idea to drive over the road again after a heavy rain and see if any further improvements can be made. If any wet spots show in the road in dry weather the cause should be investigated and either stone filled drains or perforated pipe installed if necessary.

Drainage Structures

Before any resurfacing is done, all drainage structures should be examined and, if it seems probable that all or part of these structures will have to be replaced before the surface which it is proposed to apply is worn out, the replacement should be made before the surface is applied. Under a CWA project we had a survey made of the drainage structures under our county roads. We found that on the 717 miles of county highways we had about 3,400 structures. This includes all openings under the highways from four-inch pipes to 3-span bridges. Many of the older pipes are of vitrified clay and have been badly cracked by the modern heavy loads.

It is only a question of time until all of these must be replaced. This replacement will necessitate the digging of a trench across any road surface which may be



The proposed entrance to Skyline Drive, the scenic highway at Port Jervis, N. Y., Wendell E. Phillips, Mayor. The landscaping was planned by Gerald V. S. Raynor; drawing by M. C. Wheeler; Fred X. Conrad is city engineer.

The Same *Strength of Character in Half-Ton and Big Six-Wheeler* International Trucks

Many of the toughest hauling assignments in the world fall to *International* Six-Wheel Trucks. The contractor knows from experience that he can count on Internationals for power, stamina, and economy. He knows that International service will keep them on the job. Whatever his work—from building a dam to mastering the remotest oilfield—he feels *safe* with Internationals.

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Write for the 32-page catalog on the International Six-Wheelers—the Half-Ton folder—or information on any intermediate size. The nearest Company-owned branch or International dealer is at your service.

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Illustration: *International Dual-Drive Six-Wheel Truck, Model C-55-F, maximum carrying capacity 23,000 lbs. International Six-Wheelers, Dual-Drive and Trailing-Axle, range from 11,400 lbs. up. Wheelbase lengths 168 to 244 in., permitting bodies for a wide variety of application.*

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on the road at that time. It is very difficult to fill this trench so that there will not be an uneven spot in the road surface for some time after the pipe has been installed and the trench refilled. Many of our larger bridges should be replaced with stronger structures in the near future. This will require changes in the road surface on the approaches. We feel that a road is no better than its poorest sections and that a rough spot caused by the replacement of a structure largely offsets any advantages that may be gained by its resurfacing. The inlets and outlets of drainage structures should be given attention. In many instances the cleaning away of rubbish from the inlet and the deepening of the outlet will cause a pipe culvert to carry all the water which normally flows to it with no damage to the road surface while if the same pipe is neglected serious damage will result.

Corner Monuments

The greater part of our roads are located on the section lines, consequently, we have a corner stone in the middle of the road each half mile. It was the practice for some years to remove these stones whenever they interfered with any road equipment. During the past five years we have adopted a different plan. Whenever one of these stones interferes with any construction or maintenance work which is being done on the road it is reported to our office. We then send one man from the surveyor's office and a light truck and driver from the highway department and lower the stone if it is too high or set an iron pin on top of it if the road is to be raised. The method used is to first set four reference stakes from the stone in its original position. If the stone is too high, enough gravel and dirt is removed from around the stone so that it can be pulled out with the truck. A hole is then dug and the stone placed deep enough to prevent any interference with road work, using the reference stakes to replace the markings in exactly the same position as before. If a fill is to be made so that it will be difficult to get at the original stone reference stones are placed as described above and when the fill is completed an iron pin or pipe is driven directly over the mark on the corner stone.

In laying the concrete and brick pavements some years ago, no attention was given to these corner stones. This causes a lot of extra work on land surveys in these locations. In recent years all corner stones have been carefully referenced before any pavement of a permanent nature was laid and permanent marks made in the pavement when completed. In pavements laid by the state we have cooperated with the state highway engineers in having these marks set. In the past five years we have lowered nearly 100 corner stones as described above.

Surface and Subsurface Conditions

In doing this work we noted the depth of the gravel and were somewhat surprised to find that in nearly all instances the gravel was eight inches or more in thickness. As these stones were always near the center of the gravelled part of the road we decided to dig some test holes on each side of the center line to determine whether this thickness was the same for the entire width of the road. About this time the road department decided to resurface 1¾ miles of gravel road by adding a bituminous course with rock asphalt wearing course. It was decided to dig test holes in this road to determine the exact thickness of the gravel surface then on the road. Accordingly holes were dug through the gravel on the center line of the road and at points five and ten feet each side of the center line. Along the center line these holes were about 100 feet apart with closer spacing where there were any indications that there might be a change in conditions.

Depth of Gravel

It was found that on the center line and at the points five feet on each side of the center line the gravel was from eight to ten inches thick. At the points 10 feet on each side of the center line the thickness of the gravel averaged about 4 inches. We decided that this was due to the widening of the gravel to fit modern traffic conditions after it had been dumped in the middle of the road. By digging a few trenches entirely across the road it was found that a strip in the middle of the road about 12 feet in width was gravelled with the greater depth of gravel mentioned above and the remaining four feet on each side was only gravelled to the lesser depth.

By inquiry from the residents along the road we found that the road was sometimes cut through during the spring thaws and by investigating the points where we were told that the road did cut through, we found that the defect was one of drainage rather than depth of gravel. Observations on other roads during spring thaws have led us to believe that stability is not so much a question of thickness of gravel but rather a question of the proper placing of the gravel after the road has been properly drained.

By digging some test holes in roads which were badly corrugated and at other points in the same road where the surface was comparatively smooth we were led to believe that this corrugation is quite often due to the oversize material in the gravel. Where properly graded gravel is added in thin layers over these corrugations it does not seem to help much. In fact we think that this new material is practically wasted when applied to any road that has not been thoroughly smoothed and brought to uniform texture and proper cross section before the new material is applied. Where this oversize material exists we think that it would pay to scarify the road to a depth of six inches and then remove the oversize by hand ranking if necessary. If this material could be crushed and placed back on the road without too much expense this would be a fine way to dispose of it. If this is not possible we think we would be justified in wasting it on the widening of narrow fills.

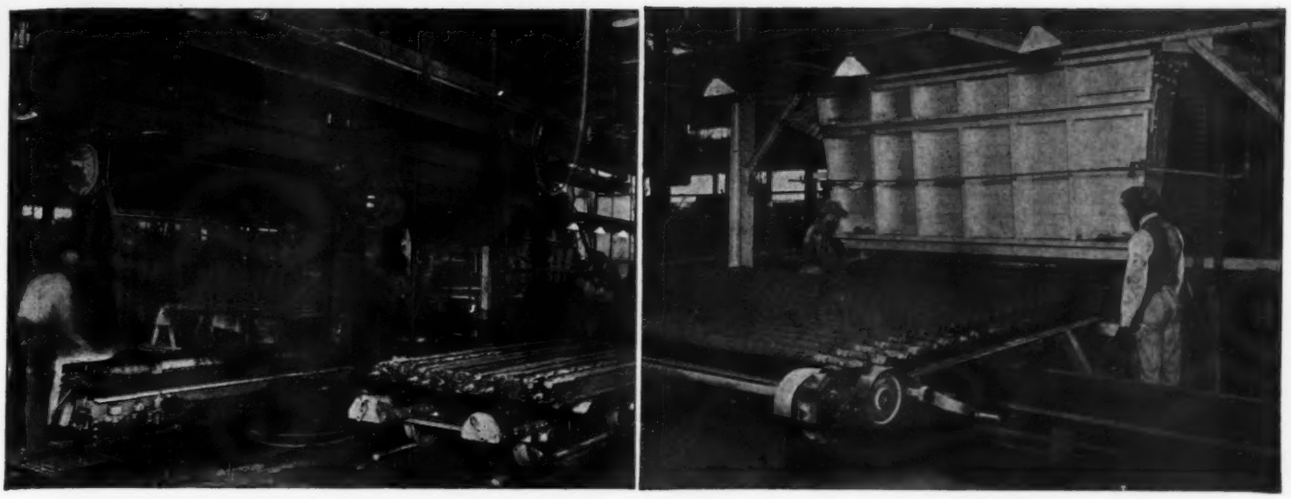
In applying gravel during the winter provision should be made for spreading the gravel each evening. If the gravel becomes frozen before it is brought to proper cross section it is very difficult ever to get it in shape and a large part of the benefit of the new material is lost as it is much easier to prevent a road from becoming rough than it is to make it smooth again after it has become rough.

Spend all the time you can in riding over roads so you will know what roads need resurfacing the most.

Don't resurface until you are sure that drainage has been well taken care of.

Don't resurface until the old road surface has been properly prepared to receive the new material.

George Gault



The genesis of a cast iron pipe; left, filling flask with sand; at the right is the core-making machine in operation, with some of the finished green sand cores showing in the foreground.

How 2-Inch Cast Iron Pipe Is Made

By ARTHUR K. AKERS

TO MANY engineers, cast iron pipe seems the same "yesterday, today and forever." Pipe laid a century ago differs but little in appearance from the 1936 product; and the long life of this pipe almost justifies the final term in the above trinity of time.

But there have been many developments. Of the three major innovations in cast iron pipe manufacture of a decade ago, one was the McWane method of horizontal casting in green sand. Until this year, this was confined to the larger sizes of pipe. Now McWane has announced the production of 2-inch cast iron pipe in 9-foot lengths, instead of the 6-foot lengths hitherto produced. Because we predict that this pipe will play an important part in engineering construction, providing a very durable and economical product for water works, sewage treatment and many other fields of construction, a brief description of the process of manufacture follows:

Process of Manufacture

The process of manufacture starts with the making of the green sand molds, for the pipe is cast in sand-lined molds about a core. Before delivery to the hoppers of the molding and core-making machines, the sand, which is a blend from many sources, is conditioned for size, strength, porosity, and moisture content.

The flasks for the molds move in front of the molding machines on two tracks, and the sand falls from the bin of the molding machine into the flask, about the

At the left, the cores are being set in molds, under micrometer control; at the right the 7-lipped ladle is pouring 9-ft. lengths of 2-inch pipe, with the temperature always under exact control.

General view of 2-inch pipe foundry, mechanical unit, McWane plant.

pattern, to form the lower and upper halves of the mold. Between the molding machines is located the core-making machine. Here a wetted, perforated core-bar, revolving rapidly under a thin apron of falling core-sand, receives this sand, which adheres to it to the proper depth. This depth is governed by a "strike" blade that removes all excess sand above an exact 2-inch diameter.

By means of conveyors, the core-bars then travel to the molds to be set. Here is the vital point in the horizontal casting method: By special patented devices the core-setting is made possible to a hair's breadth, governed by micrometer readings. Once the cores are exactly set—two to a mold—the mold is closed, and is ready for the iron.

Some of the features of this horizontal casting method are of such interest that they should be mentioned here. So remarkable is the control that it is possible to cast tapping-collars—reinforcement of the wall-thickness—at regular intervals on each pipe, so that future "wet" taps may be made through them. Again—and this will be emphasized when the subject of pipe-threading is reached—it is possible to reinforce the bells and also the spigot ends of the pipe so that neither constriction of inside diameter or weakening of pipe-wall will occur when threading.

With the molds ready, another pipe foundry innovation will be seen: In the older foundries the iron traveled to the molds. And, en route, it cooled in varying degree. In consequence, one pipe might have various defects or perfections that another lacked. Few were uniform.

But in the McWane mechanical process this is reversed; the molds do the traveling and the iron stays at home. As a result, the molten iron moves only the short distance from cupola to pouring floor, always under control of pyrometer readings.

A Special Mix for Each Pipe Size

In this new foundry each *size* of pipe is made from a different "mix" of iron. Thus in addition to a predetermined mixture of iron, under rigid heat control, the 2-inch pipe is poured, also, at its own special temperature. The shortness of its travel from cupola to mold simplifies the maintenance of this temperature within a very narrow range.

The pouring of the 2-inch pipe is accomplished, as the illustration shows, from a seven-lipped ladle, matching a similar set of openings in the top of the mold, with the melted iron traveling a mere matter of inches from ladle to final destination in the mold.

Entering the mold, the iron flows through fourteen "gates"; impurities, being lighter than the pure iron, rise to the surface and are caught here without entering the pipe itself.

As soon as the pipe has sufficiently cooled, the molds are shaken out, the gates removed, and the journey to the finishing, testing, and joint departments begun.

Cleaning and polishing of the 2-inch pipe is completed in great steel drums or "rattlers" containing hard steel "stars." Then the pipe goes to the testing-presses, to receive a hydrostatic pressure of 500 pounds, and to be given a hammer-test while under this pressure. Both of these tests are given before any standard tar coating is applied.

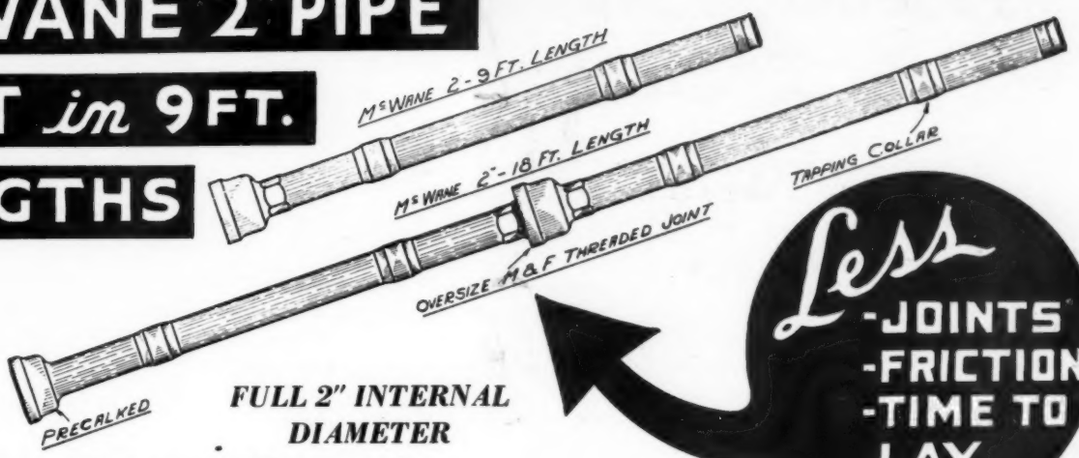
"Where Do We Go From Here"

From here on the course of travel of the pipe is determined by the type of joint that is to be given it. Much of it goes to the threading machines. The majority of all 2-inch cast iron pipe is wanted in 18-foot laying lengths. This means that the inner surface of each bell must receive a 2½-inch oversize female threading, and each spigot end a similar male thread. This is iron-pipe thread; and the dies are frequently checked by master-gauges to insure continued accuracy. Straightness of threading is insured by the method of locking the pipe into the threading machines; this avoids any possibility of a line being crooked as a result of the threading of a length not being true.

Engineering tests have proven that this method of intermediate jointing is the only one in which the joints remain stronger than any other part of the pipe.

Above, testing 2-inch pipe, 9-ft. lengths, under 500 pounds hydrostatic pressure and by the hammer test; below, testing an 18-ft. assembled length with 90 pounds of air pressure under water.

McWANE 2" PIPE CAST *in* 9 FT. LENGTHS



FULL 2" INTERNAL DIAMETER

Less -JOINTS -FRICTION -TIME TO LAY

McWane factory made joints—rigidly inspected—high efficiency. For WATER: either Improved Precalked, Oversize Male and Female Threaded or B & S. For GAS: mechanical rubber ring joints or Male and Female Threaded. Complete line of fittings!

McWane 4" and larger sizes meet Federal Specification WW-P-421.

Here's more good news! McWane 9 foot lengths are cast *mechanically* . . . the core sand and mold sand is scientifically mixed and treated.

The iron has a special analysis and is poured at *controlled* temperatures. Each individual length is given a 500 pound hydrostatic test—all assembled lengths get a 90 pound compressed air test under water.

Only McWane ships 2 inch 18 foot lengths with only *one* intermediate joint.

McWANE CAST IRON PIPE CO. BIRMINGHAM ALABAMA

PACIFIC STATES CAST IRON PIPE CO. PROVO, UTAH

***Branch Offices:* Chicago, Dallas, Denver, Kansas City, New York, Portland, Ore., Salt Lake City, San Francisco**

Since the majority of users specify shipment in 18-ft. laying-lengths, this is effected by screwing together two 9-ft. pipe at the foundry. The 18-ft. length is then tested with 90 pounds of air pressure while submerged in water.

Pipe orders frequently call for cement-lining, or special tapping, etc., and such pipe is here routed to the proper departments.

For laying the pipe, some engineers use only the threaded pipe and fittings. Others prefer the improved pre-calked type of joint. These joints are very simple and effective. A circle of California redwood wedges is placed in the bottoms of the pipe bells around an iron pattern slightly larger than the spigot-end diameter of the pipe. The bell is then filled for the remaining space with melted lead; the one-third of the joint-circumference which is to be laid on the bottom of the trench is then "pre-calked" to render bell-holes unnecessary in laying it. Then the pattern is withdrawn, protecting cylinders inserted for shipping-protection, and the completed pipe and joint are ready for service.

The new 18-ft. lengths eliminate 50% of the joints required in a main laid with the old six-foot lengths; for this reason the new 9-ft. lengths make a distinct contribution toward ease and economy of pipe-laying, and reliability of future operation.

Activated Carbon in Water Treatment

An ammonia-chlorine ratio of 1:4 is maintained at Warren, O. In algae season, residual reaching filter is 0.35 to 0.60 ppm. From 8 to 25 pounds per mg. of carbon is fed dry in the mixing chamber. C. E. Inman, supt.

Paris, Mo., uses 5 or 6 pounds of activated carbon per mg. applied at the mixing chamber. Geo. C. Blakey, supt.

Bound Brook, N. J., F. C. Brush, mgr., mixes alum and activated carbon (4%), using about 10 pounds of carbon per mg.

Buffalo, N. Y., has been experimenting with activated carbon and alum, mixed (2%). Alan D. Drake, director.

About 20 pounds per mg. of carbon is applied to the mixing chambers, by dry feed, at LeRoy, N. Y. R. J. Dooley, supt.

Application of 12 pounds per mg. of carbon to the mixing chamber, by dry feed, is reported by Westchester Joint Water Works, No. 1. W. E. Thrasher, gen. supt.

Norwich, N. Y., uses carbon at times; dosage 15 pounds per mg., applied dry at mixing chamber. C. F. Ames, supt.

Oneonta, N. Y., adds 6 pounds per mg. of carbon to water flowing to filters; dry feed. W. W. Walkins, supt.

A very little carbon is used at times at Seneca Falls, N. Y. S. W. Pratt, supt.

At Gastonia, N. C., 4 pounds per mg. of activated carbon is used, mixed with alum (2.5%). After each filter is washed, 2½ pounds of activated carbon in slurry form is applied at the influent of the filter as soon as the influent valve is opened, and is drawn quickly on the bed. C. E. Rhyne, supt. public works.

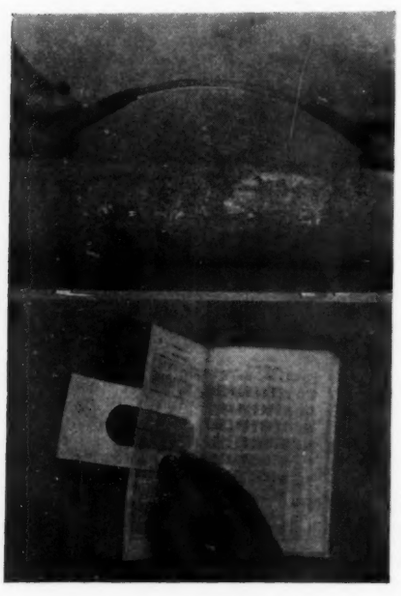
Split feed of carbon is used seasonally at Raleigh, N. C., with an average of 8¼ pounds per mg. going to the mixing chambers, and the same dose to the filters. Willis Holding, chemist.

Practical Kinks for the Engineer

Contributions to this page are invited. Send in your kinks. Public Works will pay $3 each for those published.

A Handy Device to Scrape and Clean Pipe

IT is often necessary to clean hardened mud, asbestos, insulation and many other coatings from pipe of various sizes. Most of the tools usually at hand are flat in nature, and hard to use, particularly if the work is in rather an inaccessible place. A very handy, practical and efficient home-made device can be easily made as shown herewith. Procure an old fairly heavy steel clock spring. Cut off a piece eight or ten inches long, and put a good finger grip on each end using common electrician's tape, and padding under it with tightly rolled bits of paper. If desired, sharpen both edges of the spring on the stone. This makes something in the nature of a self adjusting draw-shave. It is very easy to work with, does not readily dull, and neatly scrapes off about any kind of a coating necessary to take from the outside of pipe.



Transparent Envelope Makes Straight Line to Check or Copy from Tables

A RULER or strip of heavy cardboard is of course often made use of to maintain accuracy in copying or checking from tables, calculated rates, and numerous other compiled mathematical data. Many of such devices are hard to use with books and other types of binding. Cut out the transparent portion or address slot of an ordinary long business envelope. Rule a straight ink line horizontally through the center of it as shown. This is easily held or moved along the lines of figures, and is very easy to see and work from. With a number of lines ruled the other way, it makes a very good book mark.

Farmer's Ice Well

ACCORDING to the U. S. Bureau of Dairy Industry, the ice well method of cooling and holding cream on dairy farms proved a good investment in the Northern Great Plains area last summer. To construct an ice well, a hole approximately 9 feet square and 9½ feet deep is dug on a well-drained location convenient to the milk room and the water supply. Small to medium sized stones are set in the bottom to a depth of 1½ feet. Two by four studding are placed 2 feet apart against the earth walls. Cheap unmatched lumber nailed to the studding gives an ice storage space approximately 8 feet square and 8 feet deep. A small structure is built over the well, the floor in sections to facilitate removal, to allow free circulation of cold air when freezing the ice block in winter.

On the arrival of cold weather, water is sprinkled on the stones until a solid bottom of ice gradually freezes in the well. Snow and water may be used at the start if snow is available. Freezing the bottom of the ice chamber cannot be rushed as adding too much water at one time will melt the thin layer of ice in the bottom and allow the water to escape through the stones. Adding the water in thin layers and frequently on good freezing days and nights gives the most satisfactory results.

A 6½ foot block of ice in the well will leave room for a 5-gallon cream can between the top of the block and the floor. Experience shows that an ice well, opened for use in May, will last well into September or October.—*Journal of the Franklin Institute.*

Piece of Chain, Washer and Ring Make Wheel Block

THE thin flat iron wheels used under many portable pumps, mixers and other pieces of highway machinery are of course necessarily blocked as securely as possible to prevent vibration from moving the equipment when it is placed on a smooth sloping surface. Wooden blocks of any kind are hard to put securely under such wheels and are hard to keep in place the machines operating. Take a short piece of ¼" chain, of a length that will wrap at least twice well around the rim. Drill a hole near the edge of a large washer, then bend it over as shown in Fig. 1. Open a link at one end of the chain and secure the washer to it. Bend over a common harness ring in the same manner and apply it to the other end of the chain. The chain links need only be opened with a hacksaw and closed again around the washer rim and ring. Hook the bent washer on the rim close to the ground contact of the wheel, wrap the chain around it, and slip the half-moon shaped ring under the chain on top of the rim or inside. Tap it in snugly with a small block if necessary. The short piece of chain can be used for nothing else and as a result will always be around the machine it is used on.

Factors in Surface Treatment

THE term "surface treatment" is broadly employed to describe the methods of applying bituminous materials to a roadway for the purpose of hardening, evening and waterproofing the surface. Articles describing detail methods of construction of surface treatments have appeared in PUBLIC WORKS from time to time, and other articles are scheduled for early publication.

Surface treatments are applicable to nearly every variety of road and street, either as an original treatment to build a better surface, or as a retreatment to preserve the life and improve the riding quality of an existing surface. The principal field of use is in the so-called low-cost field, on surfaces composed of selected earth, gravel or broken stone, but this method is also of great utility in the treatment of old and rutted block or other hard surfaces.

Costs Have Declined

Costs of surface treatment have steadily declined, largely due to the great improvement in highway construction equipment. Maintenance costs likewise have declined, due in part to the more complete conditioning of road surfaces prior to the original treatment, so that pot-holing and raveling are becoming infrequent; and in part also to the rapidity with which work is done mechanically, so that overhead and lost time have less effect upon costs.

A study of 1935 costs, as compared with those of even five years ago, reveals some marked changes. For example, in 1930, treatments of ½ gallon prime and ¼ gallon seal, on state jobs, ran about $900 to $1,200 per mile. In 1935 this same class of work was being done under contract for from $600 to $900 per mile. While material costs are somewhat lower, the principal saving has come through the improvement in equipment and the complete coordination of the various operations.

Changes in Use of Equipment

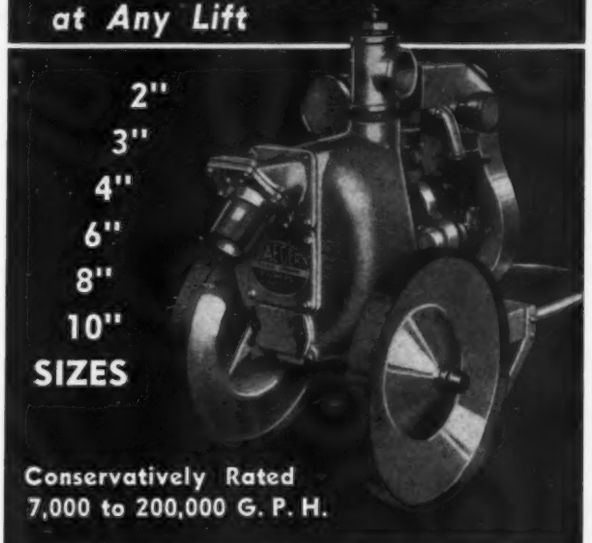
On jobs requiring a long haul, the motorized distributor now generally stays on the job, and the bituminous material is brought from the railroad tank car by trailer or booster units so as to keep the distributor constantly in operation. The cover coat, formerly placed in piles along the roadside, is now unloaded from the cars by belt conveyors, either direct to the trucks, or to a stockpile, from which it is later transferred to trucks by the same equipment. The aggregate is applied to the roadbed by mechanical spreaders, which not only do the work faster but do it infinitely better than it was ever done by hand distribution.

The introduction of the grader and the steel broom-drag as a means of uniformly manipulating the cover coat after spreading is also a development of recent years. Gasoline rollers have practically displaced steam rollers for compaction purposes. It is now possible to so coordinate the work as to have no delays except those rare and occasional ones due to mechanical breakdown. If the weather is rainy, the work stops, but the moment the roadway dries out the entire operation may proceed at full speed.

The change to pneumatic tires on all equipment has been of great importance. Hauling on pneumatic tires is not destructive to previously constructed bases as it

JAEGER "SURE PRIME" PUMPS

Fastest 100% Automatic Prime — Greater Efficiency at Any Lift



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New Catalog and Prices Will Tell You Why Jaeger Pumps Outsell All Others — Write for It.

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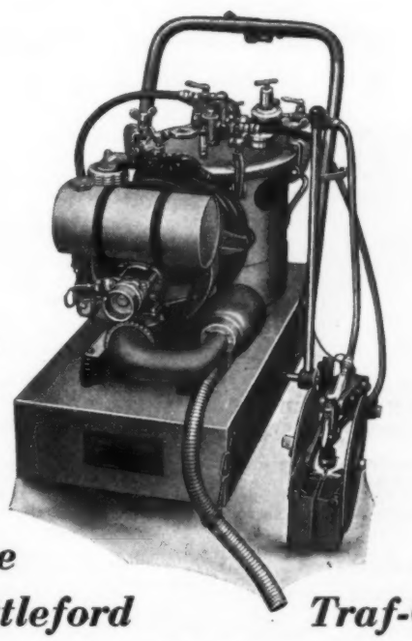

The Littleford Traf-O-Spray

Your traffic lines will be sharper, more uniform and penetrating if sprayed with a Traf-O-Spray. Use any highway paint, lacquer or emulsion on any hard surface. No hand retouching of lines is necessary. Machine is carefully built, short, light and easy to handle. Write for prices and full particulars, today.

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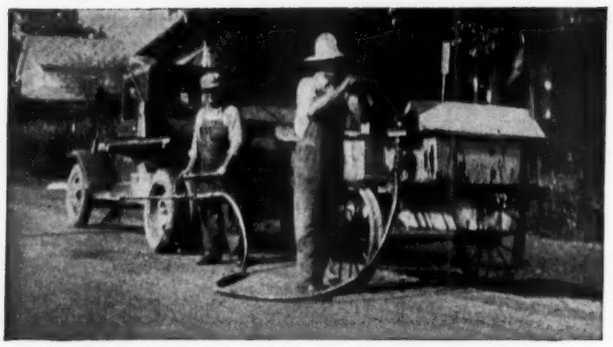

Golden Jubilee Kettle

This 50-75 gallon Littleford oil burning maintenance kettle is a "best seller."

Double heat circulation saves 20-25% on fuel for users and vents the fumes out the stack. Windproof and fireproof. A running gear that can "take it" stands up under high speed trailing and hard usage. The screened reservoir melts bitumen faster, without coking or danger of flashing.

Equipped with the Littleford hand spray, this little fellow does a real man sized job. Ask, now, for prices and particulars.

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Road Maintenance Equipment
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was with solid tires, but is often helpful. By making possible increased speed in hauling, material economies have been accomplished. The solid-tired truck, carrying a 5- to 7-ton load, had a maximum speed of 15 to 25 miles an hour, and an average hauling speed of 8 to 10 miles. Trucks on pneumatic tires, with capacities of 1½ to 3½ tons move at speeds of 35 miles an hour or more. Frequently such trucks, on hauls of 30 to 50 miles, will cover two hundred miles a day or more. In other words, even on these long hauls three full-load trips per day are possible, hauling up to 10 tons of aggregates or 3,000 gallons of bituminous material. This flexibility of modern transport equipment has had a marked effect on surface treatment work, permitting the use of proper aggregates and materials, even in areas remote from railroads and devoid of suitable local materials.

Inconvenience to the public is no longer a considerable factor. Today, a five-mile section of road may be prepared, treated and finished so rapidly that delays and complaints are no longer of importance; however, proper provision for handling traffic is necessary.

Another benefit from the increased speed and mobility of the work due to the use of equipment has been that exact planning for re-treatments, as they become necessary, is possible. In the past, it was often a problem whether to treat a surface before it was really necessary or let it go a year too long. Today treatments can be made in the exact amount required—when, as and if necessary.

Hand Labor vs. Machines

As to the displacement of hand labor by the use of such equipment, it will be realized that with modern equipment more miles of road can be improved for the same amount of money. There will be fewer laborers per mile but with the extra miles the man-hours of work will be very nearly the same. Furthermore, this labor is doing lighter and easier work, and doing it at higher average wages. Nowadays the workers are truck operators, tractor operators, mechanics on repair and maintenance of equipment, operators on mechanical conveyors, spreaders, rollers, etc.

Tractor-grader equipment is all important for road preparation prior to surface treatment, in smoothing, widening, cutting adequate ditches, etc. Graders are also used for manipulating the cover coat in the treatment of loose surfaces and, more recently, have been used in blading crushed aggregate for cover coats on heavy surface treatments, in addition to dragging and rolling.

Emphasis has been placed on the necessity of sweeping the roadway clean. The old horse-drawn sweeper was slow and the operator lived in a cloud of dust. Present-day design tends to motor driven brooms, tractor or truck-towed, with the broom placed in front where the operation is under the vision and control of the operator. Blowers are of value in removing the very fine dust which is often difficult to remove by sweeping, and also are effective in cleaning depressions and edges which otherwise may have to be swept by hand.

The Distributor

The real heart of the operation is, of course, the distributor, for if anything goes wrong with it the whole job shuts down. Its whole function is to apply bituminous material to the roadway surface, uniformly at a given rate per square yard, and to continue to do this day after day. The distributor should have a sturdy chassis and power unit; a proper pump to maintain sufficiently high and uniform pressure; a heating and circulatory system to maintain constant temperatures;

spray bars and nozzles easily and quickly interchangeable for varying roadway widths and different rates of application; and an arrangement of all the parts to facilitate necessary repair or replacement.

Distributor capacities range from 500 to 1,200 gallons in the larger sizes, with 300-gallon types for small jobs. With trailer or booster units available for hauling from distant railroad sidings, there is little necessity for distributors with capacities over 800 gallons; even the 600-gallon unit will have applying capacity enough for almost any job. The only difference will be the more frequent transfers of bituminous material from the booster or trailer to the distributor, and this rarely takes more than 5 to 10 minutes.

In the midwest, a 600-gallon distributor has placed as much as 50,000 gallons per day of cutbacks and light road oils, which did not require much heating. An average daily application of 20,000 gallons is easily possible on long jobs where the booster or trailer supply is carefully coordinated. In the east on widely separated work of relatively short lengths, the average rate of application per day will range from 4,000 to 10,000 gallons.

Planning the Job

Common-sense planning of the job in advance is necessary. Needed supplies should be accumulated in advance, or arranged for, including aggregate for the cover coat. The capacity of trucks to deliver materials at the required rate should be determined in advance, and provision made for securing one or two additional ones in case of need. Having figured the rate at which the bituminous material and cover coat can be applied, arrangements should be made for delivery of tank cars of bitumen on a regular schedule. Most of the manufacturers of bituminous road material are experienced in such arrangements, and will be glad to cooperate in the delivery of tank cars as needed to keep the work moving; or to hold up shipments when bad weather or breakdowns cause delay. Every machine or piece of equipment should, as far as possible, be insured against delay due to breakdown, repair parts or reserve units being kept available.

Control of traffic is as important on a job of this sort as on the largest primary road construction project. Provision should be made for handling traffic, both so that the work under way will not be damaged by careless or uncontrolled drivers, and so that the traveling public will suffer as little delay and inconvenience as possible due to the construction. Detours, in fair shape, should be provided, or the construction work carried on over only half of the roadway surface.

Shearing Strength of C. I. Pipe Anchor Clips

Tests to determine the shearing strength of steel anchor clips bronze-welded to cast iron pipe have been made for Sectional Committee A-21 on specifications for cast iron pipe, by the testing laboratories of Columbia University under the immediate direction of Prof. Wm. J. Krefeld, engineer of tests, and the results of the tests have just been published by that committee.

This report contains, as Part I, an introduction by A. V. Ruggles. Part II is the report on the tests, by Prof. Krefeld, and Part III is a memorandum by Leonard P. Wood, assistant engineer, Board of Water Supply of the City of New York and chairman of Technical Committee B on Corrosion and Coatings.

Copies of this bulletin may be obtained from the American Water Works Ass'n., 29 West 39th St., New York City.

Bring the Crusher to the Rock

With a portable crusher you can
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—and improve local roads.

ADVANTAGES:

1. The utilization of local materials.
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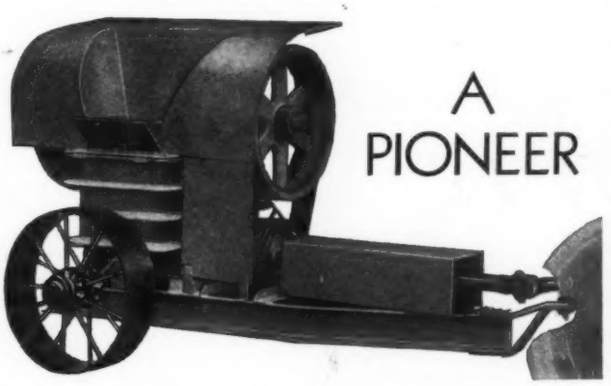

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With the Pioneer Crusher Trailer you can bring the crusher to the rock quickly and economically—use any old tractor for power—and feed the crusher by relief labor.

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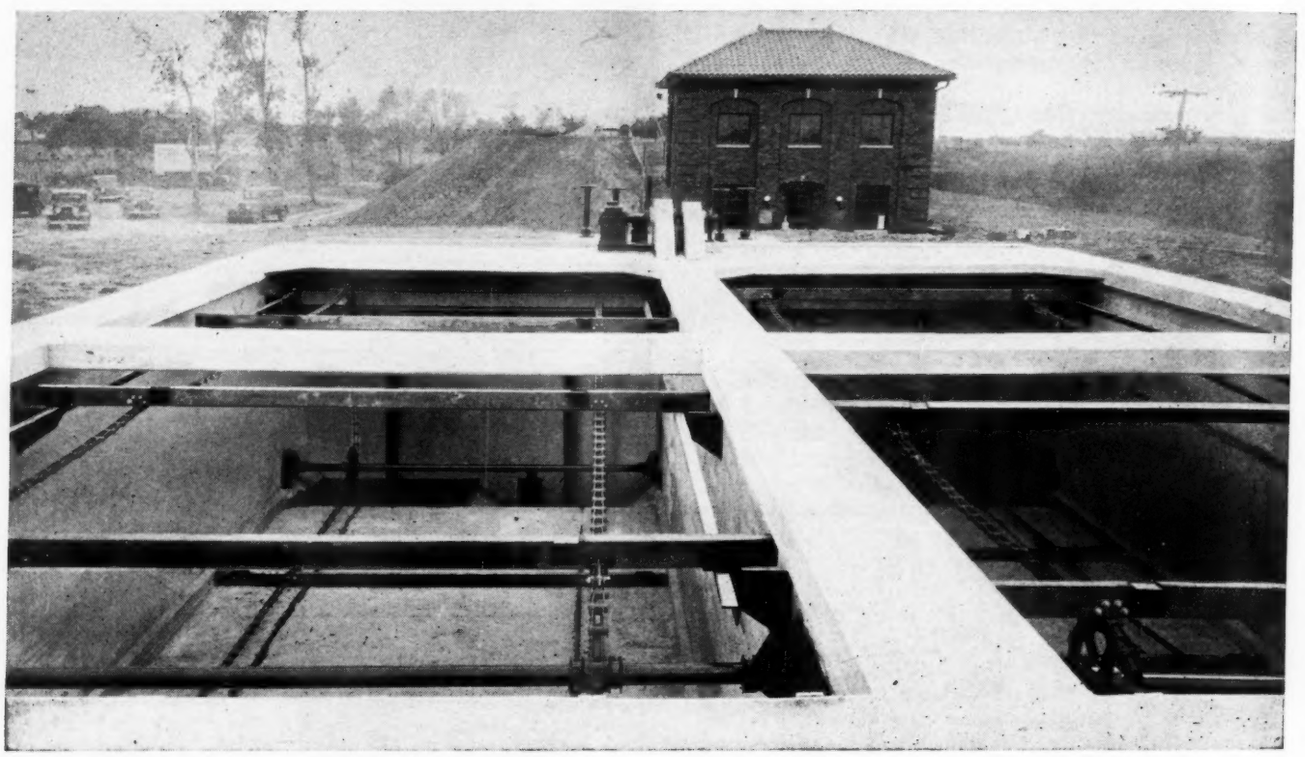

Two primary tanks equipped with STRAIGHTLINE *Collectors. City of Van Wert, Ohio. Jennings & Lawrence Co., Columbus, Engineers.*

Send for this Book. It contains installation views and considerable engineering data, including capacity tables for settling tanks, and layouts of typical arrangements for both final and primary tanks.

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CONSTANT, complete removal of sludge from rectangular flat-bottom tanks is performed efficiently by the Link-Belt Straightline collector, which for more than 12 years has given unusual satisfaction in scores of plants. High efficiency, positive results, large capacity, and low first cost, with small maintenance and power expense, are some of the reasons for the trend towards the use of the Link-Belt Straightline collector. Its simple, flexible design, accessibility for inspection, durable construction and long life, make it possible to adapt this collector, economically, to any size plant from the smallest to the largest. Send for catalog No. 1542.

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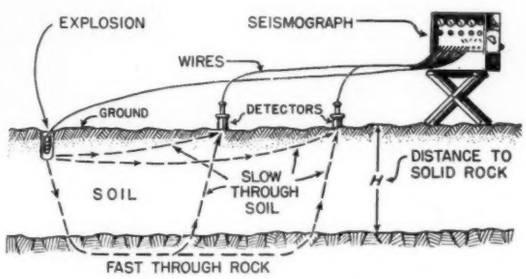
When you need special information—consult the *classified* READERS' SERVICE DEPT., pages 67-69

Sound Waves for Locating Underground Rock

BY PRECISE timing of sound waves traveling through earth and through earth and rock, engineers of the Bureau of Public Roads have developed practical field methods for determining the distance below the ground surface to solid rock. These engineers have perfected an instrument by which measurements can now be made on the surface with apparatus that will indicate within a few feet how far below the surface rock will be found. Engineers need such information in planning bridges, buildings, estimating the cost of grading for highways and for other purposes. The measuring instrument is a seismograph; the method saves the time and expense of drilling to find out how deep the rock lies.

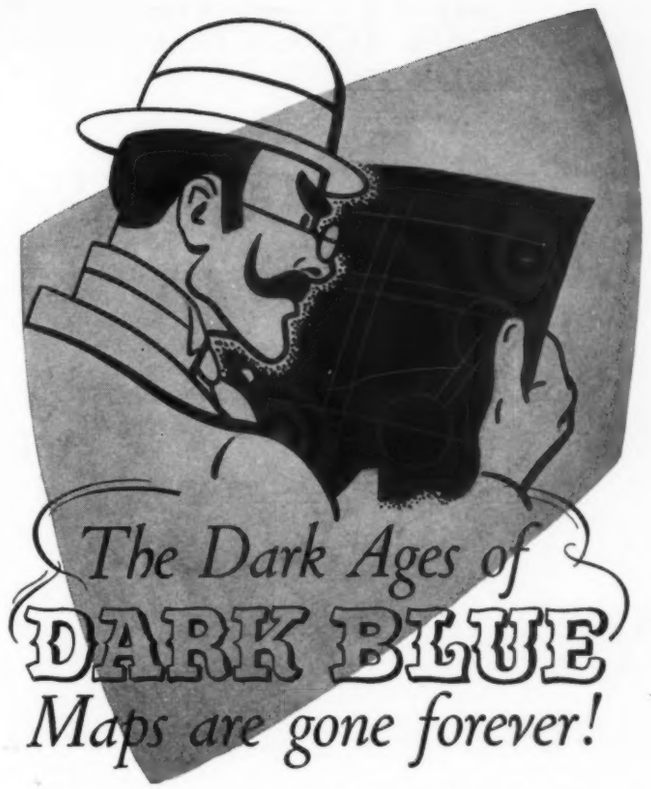
Accurate results are obtained by measuring the speed with which an impulse from the explosion of a buried blasting cap or small charge of dynamite travels through the ground. Such an impulse will travel through soil at a speed of 1,000 to 6,000 feet per second but the speed through rock is 16,000 to 20,000 feet per second. A cap is exploded in the ground and at the same time the electric current exploding the cap causes a record to be made with precise apparatus for measuring time. Special detectors are placed at different distances from the explosion and pick up the impulse as it comes through the ground. The detectors are electrically connected with the time-recording device and the time of travel of the impulse from the explosion can be measured to a small fraction of a second.



The layout of the apparatus developed by the Bureau of Public Roads for locating the depth of underground rock.

When a detector is close to the explosion one impulse coming through the soil is received. At a greater distance an impulse coming through soil is received and a second one moving down through soil to rock, through rock, and from the rock up to the surface arrives a fraction of a second later. At still greater distances the impulse moving through soil and rock arrives ahead of the impulse moving more slowly through soil alone. Knowing the speed of travel through soil and through rock and the time of travel through different distances it is possible to calculate how far the impulse went downward through soil before it encountered rock.

This method has been used extensively in prospecting at considerable depth for oil. Elaborate and costly apparatus has been used. The Bureau of Public Roads has now developed simplified apparatus that is giving excellent results, and its adaptation to the highway and municipal field may help to solve many estimating problems.



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On to California!

American Water Works Association

Following is a summary of the program of the annual meeting to be held at Los Angeles, Calif., June 8 to 13.

Sunday, June 7—Evening: 7:00, Registration; 8:00, Conference Room No. 10, Board of Directors meet.

Monday, June 8—Forenoon: 8:30, Registration; 9:30, Committee reports; 11:00, Main Session. Afternoon: 2:00, Main Session, Plant Management and Operation Division and Superintendents' Round Table Discussion. 2:00, Water Purification Division; 5:00, California Section, A.W.W.A., Directors' Annual Meeting.

Tuesday, June 9—Forenoon: 9:30, Main Session; 9:30, Water Purification Division. Afternoon: 2:00, Main Session; 2:00, Water Purification Division.

Wednesday, June 10 — Forenoon: 10:00, Main Session; Finance and Accounting Division; Sub-Committee 5-I-D, Standards of Water Quality; 10:45, Sub-Committee on Specifications and Tests for Activated Carbons; 11:30, Committee on Water Works Short Schools and Licensing of Water Works Employees.

Thursday, June 11—Forenoon: 9:30, Joint Session of General Membership and Water Purification Division; Finance and Accounting Division. Afternoon: 2:00, Plant Management and Operation Division; 5:00, Board of Directors.

The social side of the meeting will be well cared for. The entertainment program: Monday, June 8: 6:30, Dinner, "Service des Eaux"; 9:00, Reception and dance, informal, Biltmore Bowl.

Tuesday, June 9: 7:15, All-Division dinner, informal, Biltmore Bowl.

Wednesday, June 10: 8:00 A.M. Breakfast at The Los Angeles Breakfast Club; Golf Tournament; Excursion; 9:00 P.M. Smoker, Biltmore Bowl.

Thursday, June 11: 12:30, Luncheon, Finance and Accounting Division; 7:30, Dinner dance, informal, Biltmore Bowl.

Dates of Ladies Luncheon Bridge and Sight-seeing Trip will be announced later.

The following prizes and honors have been awarded:

To Harry E. Jordan, Chemical Engineer of the Indianapolis Water Company and immediate Past-President of the American Water Works Association, was voted the John M. Diven Memorial Medal. This Medal is annually awarded to that member of the Association who has performed an outstanding service in the interest of the Association. As most prominent of the several valuable services which he has rendered, and is rendering, Mr. Jordan was selected for his efficient and laborious enterprise in directing the work of the Joint Editorial Committee of the American Water Works Association and the American Public Health Association on the Standard Methods of Water Analysis. Out of this has come a new edition of "Standard Methods for the Examination of Water the Sewage," which is now in press.

To Mathew M. Braidech, Senior Chemist, Baldwin Filtration Plant, Cleveland, Ohio, was awarded the John M. Goodell Prize. This prize is annually presented to that member of the Association who has made a notable contribution to the science and practice of water work-development which has been recorded in the form of a paper published in the Journal for the current year or whose contribution to water works service and practice may have been judged to be sufficiently notable within the last three years, even if no record of it has appeared in the Journal. The award was made to Mr. Braidech for his paper "The Spectographic Determination of Minor Chemical Constituents in Various Water Supplies in the United States," Journal A.W.W.A., Vol. 27, page 557. The associate author of this paper, F. H. Emery, is not a member of the American Water Works Association and therefore cannot share in the prize.

The Board of Directors have selected the following five active members to receive the distinction of becoming Honorary Members:

M. N. Baker, Montclair, N. J., a member since 1903, for many years represented "Engineering News" and subsequently "Engineering News-Record" in the water works field. Mr. Baker retired from the editorial staff of "Engineering News-Record" on July 1st, 1932 and for several years past has been engaged in preparing for the American Water Works Association the story of water treatment under the title of "History of Water Purification."

Dr. Edward Bartow, member since 1906, is Professor of Chemistry and Chemical Engineering, State University of Iowa, Iowa City, Iowa. Dr. Bartow served as President of the Association in 1921, and has taken a very active part in the Association's activities, contributing many papers in the field of water purification. He has also contributed extensively to the literature on sewage treatment. At present Dr. Bartow is President of the American Chemical Society and is a member of many American and foreign technical societies.

Charles R. Henderson, member since 1901, for many years has been Manager of the Davenport Water Company, Davenport, Iowa, and was President of the Association in 1918, at which time he held the same position with the Davenport Water Company. Mr. Henderson in the past has taken an active part in the work of the Association.

Nicholas S. Hill, Jr., member since 1901, Consulting Engineer, New York, N. Y., was President of the Association in 1915 and is at present, Chairman of the Committee on Electrolysis and Electrical Interference. Mr. Hill is President of the Hackensack, N. J., Water Company, a member of many technical associations and has contributed extensively to the literature of the engineering field.

Edward E. Wall, member since 1904, Consulting Engineer, St. Louis, Mo., served as head of the Water Department, St. Louis, Mo., for many years and is now Director of Public Utilities. Mr. Wall has taken an active part in various technical societies and is a Past-President of the Engineers' Club of St. Louis.

National Lime Association

The 18th annual convention of this association will be held at Hot Springs, Va., June 3 and 4, 1936. W. V. Brumbaugh, 927 15th St., N. W., Washington, D. C., is secretary.

Personal News

A. J. Hawkins, formerly city engineer of Birmingham, Ala., and more recently in charge of WPA work in Alabama, has been elected director of the Alabama State Planning Board, a recent creation of the legislature.

August Sauer, former Philadelphia engineer, who moved to Texas some time ago, has been appointed resident engineer inspector of the PWA, with headquarters at Alpine, Tex.

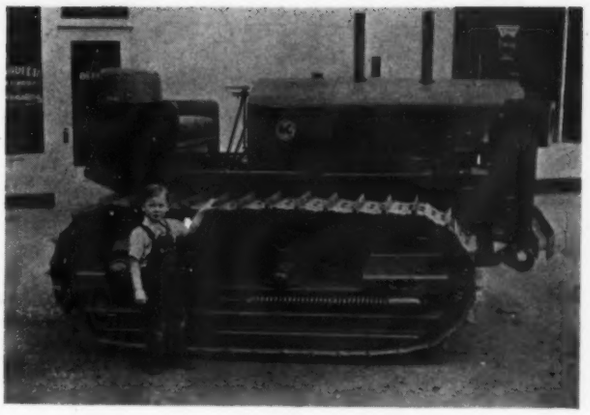
T. E. Transeau has been appointed traffic engineer of the Philadelphia, Pa., Department of Public Safety.

L. M. Funderburg has been appointed superintendent of the Leeds, Ala., plant of the Universal Atlas Cement company, a subsidiary of the United States Steel corporation. He succeeds B. E. Merrell whose death occurred March 4. Mr. Fundderburg has been with the company over 12 years and since May, 1930, has been assistant plant superintendent at Leeds. Prior to his cement connection he was plant engineer for the Alabama By-Products corporation. He was born in Gadsden and attended the Alabama Polytechnic institute.

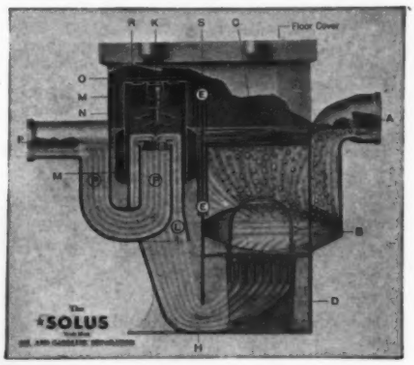
Alfred Kaufman, newly elected president of Link-Belt Co., who succeeds George P. Torrence, has been with the company for 35 years, serving in many key positions. He has held the presidency of his firm previously.

Ideas in New Devices

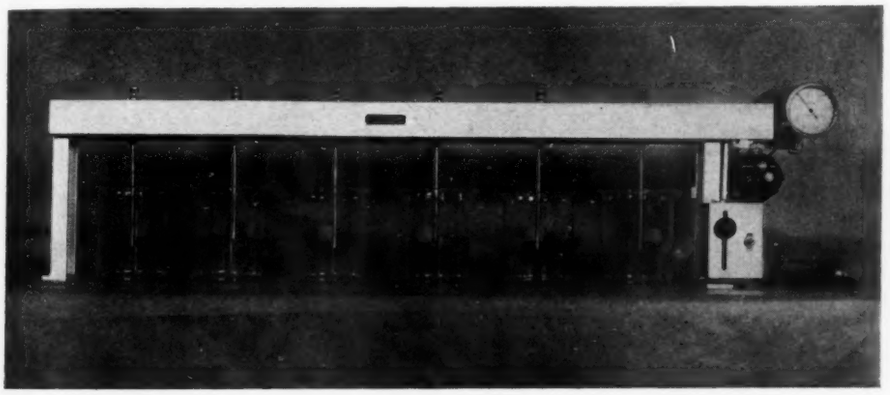
Now is the most effective time to use weed burners. After the seed has sprouted up with green foliage, it is naturally going to take a greater amount of heat to burn up each weed. After an area has been once burned off, it does not mean this space will be forever rid of weeds. Lighter weed seeds are blown around by the wind, and sooner or later they will again grow up in a spot that has once been cleared off. An effective way of destroying them is with a Littleford Weed Burner. This is a good way to put men to work on WPA projects.



Warren Chandler, at the ambitious age of 3, started and stopped this Allis-Chalmers tractor unaided more than 40 times. This was in La Grande, Ore. These western youngsters certainly start young. Will he be a contractor or an engineer when he grows up? Or an actor?



This separator ought to be required on every garage connection, and on every other place where oil, gas or other possibly explosive compounds may enter sewers. Neat and complete booklet on request to Henry Hoeltge, Central Fdry. Co., 420 Lexington Avenue, New York.



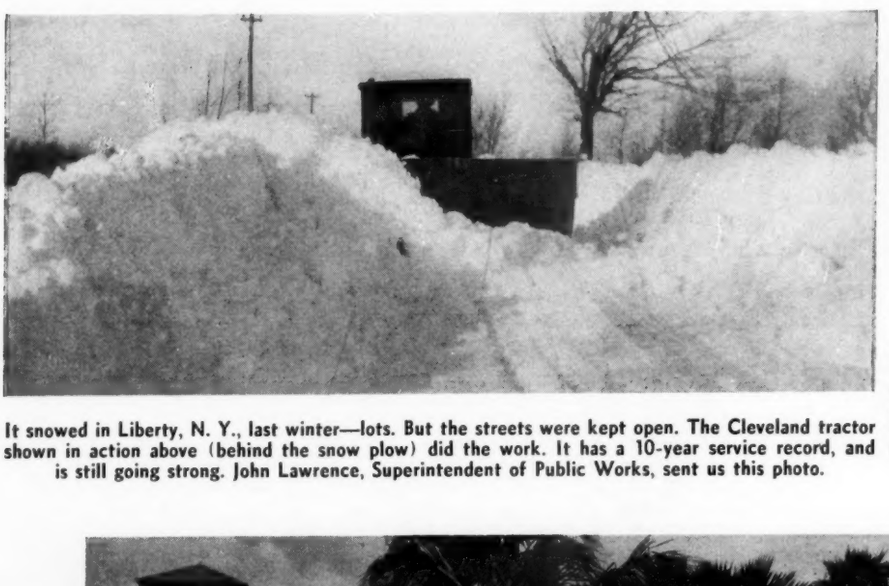
Above:
This picture of the new Phipps & Bird laboratory mixer doesn't begin to do justice to this new device. All that the most rabid research man could ask for—and the price surprisingly low. Developed, we understand, from plans by Chris Bingham and especially for Fred Stuart's traveling laboratory shown on another page. Speeds from 15 to 110 rpm. Equipped with a speedometer shown at the upper right. 1000 c.c. pyrex beakers can be used for the jars. For full details write Phipps & Bird, 915 E. Cary St., Richmond, Va.

At right:
An air view showing terracing work completed by the Parsons Whirlwind. This is a new development for small grading operations, such as farm terracing. Suited also for municipal, county and state construction work. The Parsons Co., Newton, Ia., will send complete information on this device on request. It operates through a power take-off from an ordinary farm tractor. Costs per acre for terracing are reported to run from 88 cents to $1.54; it is said to average 400 to 700 feet of terrace per hour of field time.

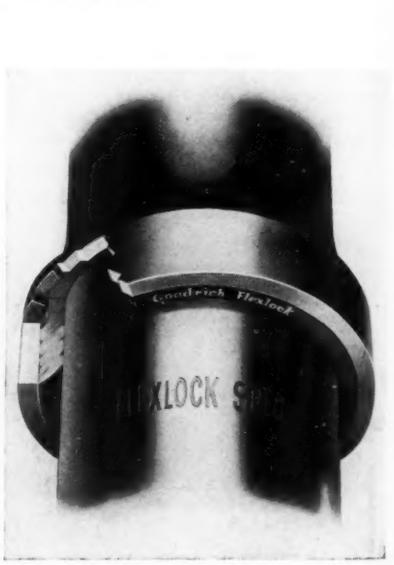
NEWS—PICTURES

Hercules Steel Products Co., Galion, O., are now furnishing this Sullivan air compressor mounted on a 1½-ton short wheel base Chevrolet truck. The compressor is operated by a Hercules power take-off, which permits the entire power of the truck to be used for operating the auxiliary equipment.

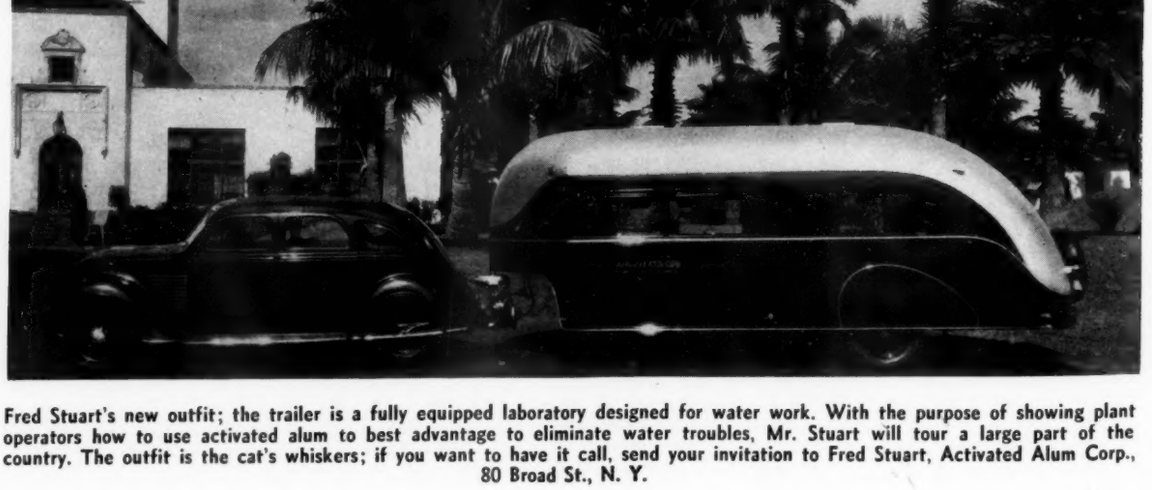
This is a hydraulic pusher for putting pipes, wires, etc., under walks, pavements and lawns. Weighs only 125 pounds, but can exert 40,000 pounds pressure. Handles pipe 1¼ to 4-inch, and has 8 speeds for varying soil conditions. Write Greenlee Tool Co., Rockford, Ill., for dope on this convenient and economical tool.



It snowed in Liberty, N. Y., last winter—lots. But the streets were kept open. The Cleveland tractor shown in action above (behind the snow plow) did the work. It has a 10-year service record, and is still going strong. John Lawrence, Superintendent of Public Works, sent us this photo.



Goodrich Flexlock joint for pressures up to 15 lb. in ceramic pipes. Proof against acids, alkalies, etc. Doesn't pull apart; pressure makes it tighter. Does not corrode. Installed with ordinary workmen; can be used in most unfavorable conditions. Write B. F. Goodrich Co., Akron, O., for details.



Fred Stuart's new outfit; the trailer is a fully equipped laboratory designed for water work. With the purpose of showing plant operators how to use activated alum to best advantage to eliminate water troubles, Mr. Stuart will tour a large part of the country. The outfit is the cat's whiskers; if you want to have it call, send your invitation to Fred Stuart, Activated Alum Corp., 80 Broad St., N. Y.

Readers' Service Department

These booklets are FREE to readers of PUBLIC WORKS.

CONTINUED FROM PAGE 68

bulletin just issued by Filtration Equipment Co., 350 Madison Ave., New York, N. Y.

Couplings for Pipe

386. This sixteen-page booklet is a reprint of a magazine article by a consulting engineer. It describes in detail the installation of a 42" water line; contains specific information regarding pipe joints, field organization, laying pipe, tests, back-filling, etc. Sent free by S. R. Dresser Manufacturing Company, Bradford, Pa.

Fire Hydrants

388. Two new bulletins on M-H fire hydrants and fully bronze mounted gate valves are now ready. Contain full specifications and instructions for ordering, installing, repairing, lengthening and using. Write M. & H. Valve & Fitting Co., Anniston, Ala.

Gate Valves

390. 28 page catalog contains illustrations and complete specifications of M-H standard and extra heavy iron body gate valves, horizontal swing check valves, flanged fittings and flanges, etc. Sent promptly on request by M. & H. Valve & Fittings Co., Anniston, Ala.

Glass Covers

393. Full details regarding the use of Lord & Burnham Glass-Overs at Middletown, N. Y.; Marion, Ohio; Cleveland, Ohio; Freeport, N. Y.; Kitchener, Canada; West Chester, Pa., and other places are given in bulletins 22 to 33. Sent promptly on request to Lord & Burnham Co., Irvington, N. Y.

Laboratory Equipment

400. The Phipps & Bird Stirrer, the solution feeder, a forthcoming stirrer using air for mixing, and all sorts of laboratory equipment for water and sewage plants. Bulletins and folders covering these pieces of equipment are complete and interesting. Phipps & Bird, Inc., 915 East Cary St., Richmond, Va.

Manhole Covers and Inlets

403. Nuisance from loose, noisy manhole covers is eliminated by the use of Westeel rubber cushioned manhole covers and gratings. Six special advantages are explained in a new illustrated bulletin just issued by the West Steel Casting Co., 805 East 70th St., Cleveland, Ohio.

404. Street, sewer and water castings made of wear-resisting chilled iron in various styles, sizes and weights. Manhole covers, water meter covers, adjustable curb inlets, gutter, crossing plates, valve and lamphole covers, ventilators, etc. Described in catalog issued by South Bend Foundry Co., South Bend, Ind.

405. "Standard Construction Castings" contains 32 pages of useful data sheets giving specifications and detailed sketches of a wide variety of frames, manhole covers and other castings. Every municipal engineer should have one. Flockhart Foundry Co., 82 Polk St., Newark, N. J.

Pipe, 2-inch Cast Iron

407. The new McWane 2" cast iron pipe in 18-foot lengths has innumerable uses in water and sewage work. Send for the new McWane bulletin describing this pipe, the various joints used, and other details about it. McWane Cast Iron Pipe Co., Birmingham, Ala.

Pipe Forms

409. Making concrete pipe on the job to give employment at home is the subject of a new booklet just issued by Quinn Wire and Iron Works, 1621 Twelfth St., Boone, Ia., manufacturers of "Heavy Duty" Pipe Forms. Sent promptly on request.

Pipe Joints

410. New folder describes in detail a new type of pipe joint—the Dresser Compression Coupling, Style 65, which is compact and self contained, makes a permanently tight joint under all conditions and is installed on plain end pipe in a few seconds with only one tool, a wrench. Get your copy today. S. R. Dresser Mfg. Co., Bradford, Pa.

Pipe Joint Compound

411. A new bulletin has recently been issued giving full details concerning Tegul Mineralead, a quick-sealing, trouble-free compound for bell and spigot joints which permits immediate closing of the trenches. Write The Atlas Mineral Products Co. of Pa., Mertztown, Pa.

Taste and Odor Control

412. How, when and where activated carbon can and should be used to remove all kinds of tastes and odors from water supplies is told in a new booklet just issued by Industrial Chemical Sales Co., Inc., 230 Park Ave., New York, N. Y. 32 pages, table, illustrations and usable data.

Protective Pipe Coating

413. Coal-tar Pitch Enamels for exterior and interior linings for steel water lines; highly resistant to water absorption, soil acids and alkalis. Technical specifications for materials and their application will be sent on request. The Barrett Company, 40 Rector St., New York, N. Y.

Pumping Engines

414. "When Power Is Down," gives recommendations of models for standby services for all power requirements. Sterling Engine Company, Buffalo, N. Y.

Rubber Lined Pipes and Pumps

415. New, 68-page catalog describes Ace rubber lined pipe and fittings, hard or soft rubber lined centrifugal pumps and Ace hard rubber double acting pumps, for chemicals used in treating sewage and water and for acids and other corrosive liquids. Contains illustrations and specifications. Issued by American Hard Rubber Co., 11 Mercer St., New York, N. Y.

Runoff & Stream-Flow

416. Technical information on measuring run-off, both from small areas, for storm sewer design, and from large areas for determining water-shed yield, and instruments for measuring. Julien P. Friez & Sons, Baltimore, Md.

Screens, Sewage

417. The simple, automatic Loughlin, self-cleaning travelling screen is fully described in an interesting bulletin issued by Filtration Equipment Co., 10 East 40th St., New York, N. Y.

421. Sewage screens (Tark, Brunotte, and Straightline) for fine and coarse sewage; Straightline Collectors for Settling Tanks (Sludge, Scum and Grit), and Mechanical Aerators for activated sludge plants. Link-Belt Company, 307 No. Michigan Ave., Chicago, Ill. Book 642.

Small Septic Tanks

425. Very handy and complete data on small septic tanks and their installation, and also on the construction of means for final disposal of the tank effluent; also on waterless chemical toilets. San-Equip, Inc., 615 East Brighton Ave., Syracuse, N. Y.

Rainfall Measurement

429. The measurement of precipitation, exposure of gauges, description of apparatus for measuring rainfall, both rates and amounts. Bulletin RG and Instruction Booklet. Julien P. Friez & Sons, Baltimore, Md.

Screens

430. Water Screen Book No. 1252, describes water screens and gives complete technical information about them. Link-Belt Co., 307 No. Michigan Ave., Chicago, Ill.

Sludge Bed Glass Covers

432. Sludge Bed Glass Covers—"Super-Frame." Hitchings & Co., Elizabeth, N. J. Offer A. I. A. File 101SB, describing glass covers for sludge and sprinkler beds; details, specifications and cost data.

Sludge Drying

436. Relatively dry cake sludge in demand for fertilizer is produced by automatic continuous vacuum filters like those used in Milwaukee, Houston, Chicago, Gastonia, N. C., Charlotte, N. C. Write for literature. Oliver United Filters, Inc., 33 West 42nd St., New York, N. Y.

Sludge Incineration

438. A multiple hearth furnace which meets the most exacting municipal sanitary requirements for the incineration of sewage sludge—produces a fine ash or partially dry sludge for fertilizer—is described and illustrated with drawings and photographs in bulletins issued by Nichols Engineering and Research Corp., 40 Wall St., New York, N. Y. Operation as well as installation data is given.

440. Disposal of Municipal Refuse: Planning a disposal system; specifications. The production of refuse, weights, volume, characteristics. Fuel requirements for incineration. Suggestions for plant inspection, 45 pp., ill. Also detailed outline of factors involved in preparation of plans and specifications. Morse-Boulger Destructor Co., 202P East 44th St., N. Y.

Sludge Removal Equipment

442. If you are interested in economical sludge removal, write for the latest bulletin describing and illustrating Louden Monorail equipment which is adapted to open or closed beds. Full details sent promptly by the Louden Machinery Co., 400 West Ave., Fairfield, Iowa.

Swimming Pool Equipment

444. Filters, chlorination, underwater lights and other supplies for swimming pools are very thoroughly described in literature and folders. Plans and layouts. Everson Filter Co., 625 W. Lake St., Chicago, Ill.

445. Data and complete information on swimming pool filters and recirculation plants; also on water filters and filtration equipment. For data, prices, plans, etc., write Roberts Filter Mfg. Co., 640 Columbia Ave., Darby, Pa.

Treatment

448. New 31-page catalog covers complete conveying, screening and reduction machinery for water purification and sewage treatment; describes and illustrates the design features of Jeffrey self-cleaning bar screen, combined screen and grinder, sewage screenings grinder, grit washer, conveyor type and positive discharge sludge collectors and green garbage grinder—includes installation views. Catalog 615, Jeffrey Manufacturing Co., Columbus, Ohio.

449. Installation views and considerable engineering data including capacity tables for settling tanks and layouts of typical arrangements for both final and primary tanks, are contained in a new booklet—No. 1542—just published for engineers by Link-Belt Company, 307 No. Michigan Ave., Chicago, Ill.

450. Standard Sewage Siphons for small disposal plants and PFT Rotary Distributors are new catalogs recently issued by Pacific Flush Tank Co., 4241 Ravenswood Ave., Chicago, Ill. The latter catalog contains typical plans and many illustrations of actual installations.

452. Eliminate sludge bed troubles, forget about weather conditions, odor nuisance, hail insurance and the like. Full details as to how Oliver United Vacuum Filters overcome these problems will be sent to all interested by Oliver United Filters, Inc., 33 West 42nd St., New York, N. Y.

453. Collectors and concentrators for modern sewage treatment plants, recent installations, and full data on aerators, and screens. Link-Belt Co., 307 No. Michigan Ave., Chicago, Ill., and Philadelphia.

454. Full information regarding their newest equipment for sewage treatment and water purification will be sent on request by The Dorr Co., 247 Park Ave., New York, N. Y.

For the Engineer's Library

The editors will be glad to assist readers in getting copies of publications mentioned here.

Highway Subdrainage

Especially timely, in view of the current extensive damage to highways and streets by water and frost action, is a new 32-page bulletin entitled, "Subgrade Drainage for Modern Roadways."

Relation of soil studies to the problem is briefly described, with the conclusion that soil moisture is the principal cause of unstable subgrades. Drainable and undrainable soils are defined, with the added statement that a larger portion of subgrade soils can be effectively drained than is generally believed. Various subgrade treatments are described including the use of admixtures and porous sub-bases, but with emphasis laid on drainage as being the fundamental requirement. Drainage is divided into two classes—interception drainage and drainage to lower the water table. Typical cross-sections and recommended installation practices are shown, as well as numerous other illustrations. Copies of this bulletin, H-36, may be obtained free of charge by addressing the Armco Culvert Manufacturers Association, Middletown, Ohio.

Tin and Zinc Coating:

Here is a powder which is claimed to replace tin or zinc galvanized surfaces that have been worn, damaged or burnt by welding. Mix with water and spray or paint. Also usable dry. Directions and information from American Solder & Flux Co., Wayne & Berkley, Philadelphia, Pa.

Operating Costs of Light Trucks:

A report by the Metropolitan Life Insurance Co., Policyholders Service Bureau, N. Y., which gives results of detailed studies of operating costs of trucks of 1½ tons capacity or less. There are 24 detailed operating costs tables. Information has been obtained principally from fleets using identical accounting methods. Copy on request to above address.

Specifications for Painting Water Tanks:

A complete set of specifications and directions for painting elevated water tanks; also a great deal of good information on painting and protection of metals. Prepared by Joseph Dixon Crucible Co., Jersey City, N. J., but applies fairly, we believe, to all paint jobs. Sent on request to R. E. Mitchell at the above address.

Highway Safety:

A 24-page illustrated booklet just published by The Four Wheel Drive Auto Company, Clintonville, Wisconsin, and Kitchener, Ontario, Canada. In color and detail a story of automotive safety is brought to the reader. Statistics regarding 1935 highway accidents and causes of such are shown in a clear and forceful manner. Truck operators may secure free copies by writing to the manufacturer.

Modern Steam Engines:

A 48-page book on "Modern" Steam Engines, which gives a lot of information on the subject, is available from Troy Engine and Machine Co., Troy, Pa. Maybe its time to refresh your knowledge on this type of power.

Oxwelding Brass and Bronze:

Linde Air Products Company, 30 East 42nd Street, New York City, has issued a 12-page, excellently illustrated booklet on the oxy-acetylene welding of brass and bronze.

There are two main sections to the booklet. One is devoted to the technique of fusion welding brass and bronze. The other to the welding of commercial yellow brass pipe. Joint design and welding technique are discussed in detail. Three tables give data on welding time, material consumption, and tensile strength of welds made in various positions. Copies on request.

Colors and Finishes Cast Stone

The Bureau of Standards has just issued a pamphlet "Colors and Finishes for Cast Stone," Commercial Standard CS53-35. This aims to assist the writers of architectural specifications and designers of buildings by listing a series of standard samples of cast stone covering the more commonly selected finishes and colors available in that material. These particular colors and textures were selected by a committee of architects, and include rubbed, brushed, etched, and bush-hammered finishes, buff and gray colors. Copies from Gov't Printing Office, Washington, D. C., at 5 cents each.

Stabilized Road Maintenance:

A new 14-page bulletin by the Calcium Chloride Assn., Penobscot Bldg., Detroit, Mich., gives excellent information on this subject. Ask for Bulletin No. 18. Sent on request.

Pacific Flush-Tank Elects New Officers

At the forty-third annual meeting of the Pacific Flush-Tank Company held at their Chicago office, the following officers were elected for the ensuing year: Lester E. Rein, President; Harry E. Schlenz, Vice-President; D. M. Burwell, Treasurer; L. E. Langdon, Secretary. The Eastern office at 441 Lexington Ave., New York, N. Y., continues under the management of Lionel L. Langford. The Pacific Flush-Tank Company has, since its inception in 1893, concentrated continuously and exclusively on the design and manufacture of sewer and sewage treatment equipment.

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